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VOL. XVI CHICAGO, SEPTEMBER 1, 1912 No. 17

THREE HUNDRED THOUSAND HORSEPOWER

To Be Developed at Keokuk, Ia., by Pouring the Mississippi River Through Turbines Under 32 ft. Head—Details of Dam and Power Plant

SUPPOSE THAT SOME fine crisp, fall morning the order came down from "up stairs" to gather up the Mississippi River, pour it into the funnel of a coffee mill and grind out dollars! It would make you sit up and do some tall thinking—don't you think?

That is, however, just about the proposition that the engineer undertook when he started the development of the water power at Keokuk, Iowa, and that is the proposition which he is now carrying toward completion. Natural surroundings favor the work, but even so it is a task which even Hercules might have hesitated to undertake.

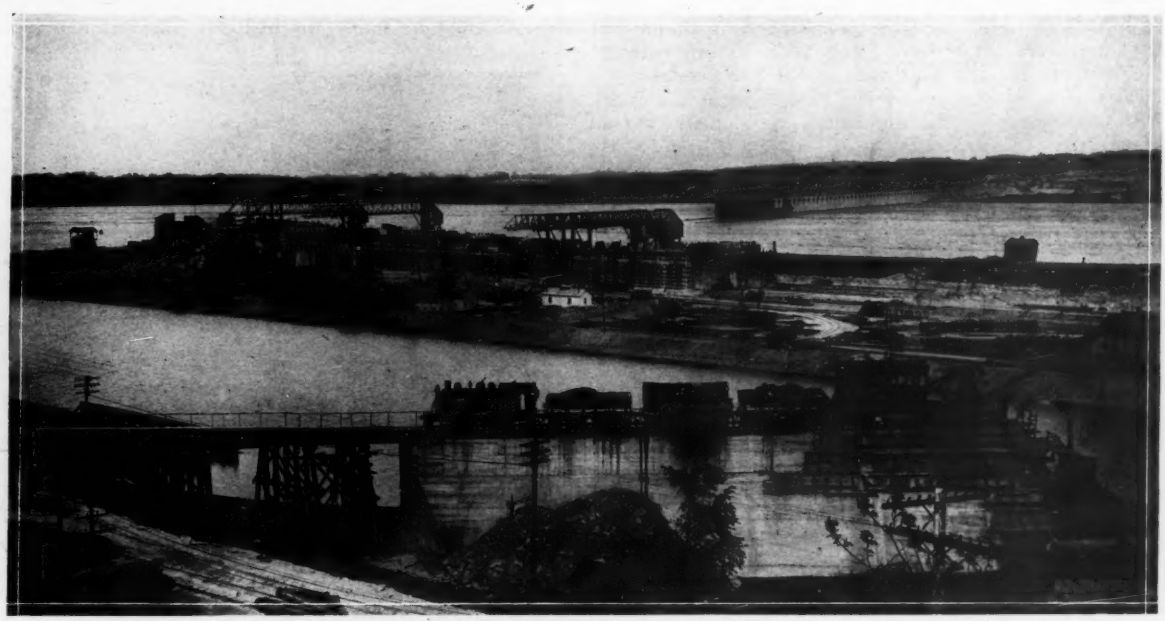


FIG. 9. VIEW OF POWER HOUSE UNDER CONSTRUCTION, PRESENT GOVERNMENT CANAL, PART OF SEA WALL, AND COMPLETED ARCHES OF THE DAM IN THE BACKGROUND

Early Dreams

PROPOSAL of such a development dates back to a time before the Civil War when Robert E. Lee, as a lieutenant in the army, was stationed near Keokuk and reported to the War Department that, although the time would be far in the future, an immense power was possible from the river at that point. In a distance of 12 miles, the drop in the river is 23 ft., making a rapid flow which is difficult for the small up-river boats to navigate, and, in consequence, for many years a series of locks and a canal at the west side of the river have been maintained by the federal government.

During 40 years people dreamed, talked and

planned of using this great power and citizens of Keokuk, and Hamilton, Ill., just across the river, organized a corporation to take the necessary steps. Money was appropriated by the city councils and the state legislatures lent their interest and aid. Congress investigated, cautiously, and finally gave its consent provided that every detail should be approved by the War Department, which meant that any development must provide free the necessary locks, a dry dock and motive power to operate them perpetually as well as deep water navigation for many miles up the river. This was a big gift to make, and capital, always

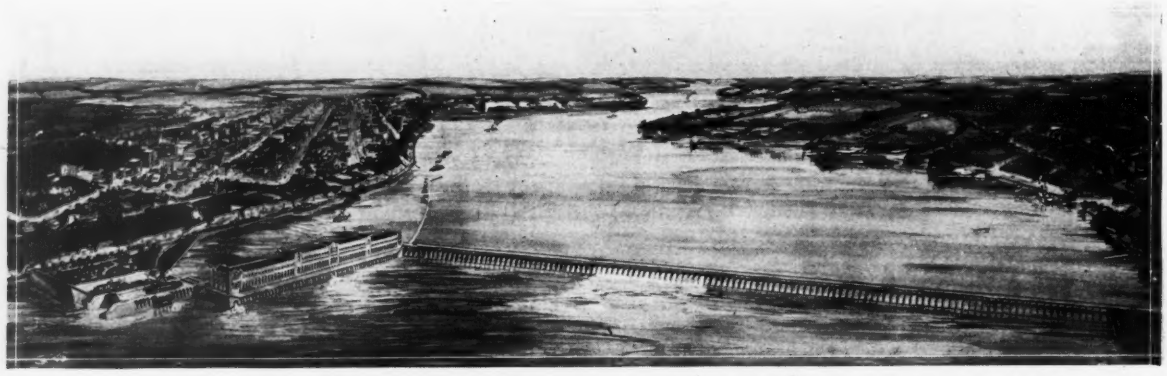


FIG. 1. GENERAL VIEW OF THE COMPLETED WORK

timid, hesitated long before consenting to dump an investment of millions in the bed of the Mississippi on the hope that after a time interest on the investment would be returned.

In the early plans only part of the flow of the river was to be utilized by means of wing dams, but an engineer who was engaged to investigate the matter, decided that the 10,000 hp. available by means of a wing dam on the east side of the river, without disturbing the old canal, could be increased

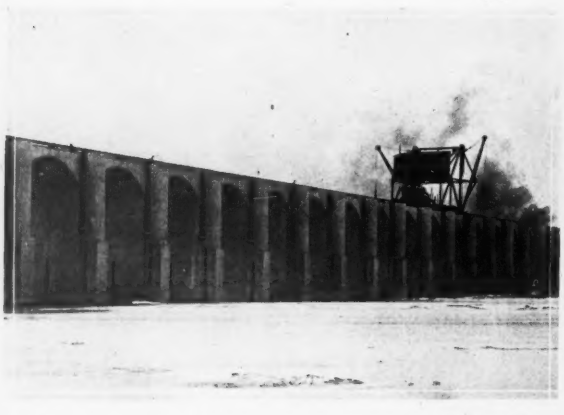


FIG. 2. DAM FROM THE UPSTREAM SIDE WITH TRAVELER

to 40,000 h.p. by damming the river entire at Nashville, 8 miles above Keokuk.

Several years later, Hugh L. Cooper, a man who had experience in conquering difficult development problems of water power plants, took up the proposition, starting out to raise the funds to carry on the work and to organize a new company for this purpose. This he did, taking over the rights of the old company, reimbursing the cities for what they had already done, and securing the approval of the War Department for the plans which he made. He succeeded in interesting capital from the eastern part of the country and from Europe, and the Mississippi River Power Co., was organized with Edwin F. Webster, of Boston, Mass., as president and Mr. Cooper as vice-president and chief engineer.

The Problem and the Man

FIGURES are dry things even if connected with so wet a subject as the Mississippi River, but figures must be used to give some idea of the immensity of this project. Here is a mighty river spreading nearly a mile in width and having a depth of 7 ft. and carrying a flow of 20,000 cu. ft. a second at low water and 372,000 cu. ft. at high water to be dammed, controlled and bent to the will of the engineer, and provision must be made for utilizing this mighty force,

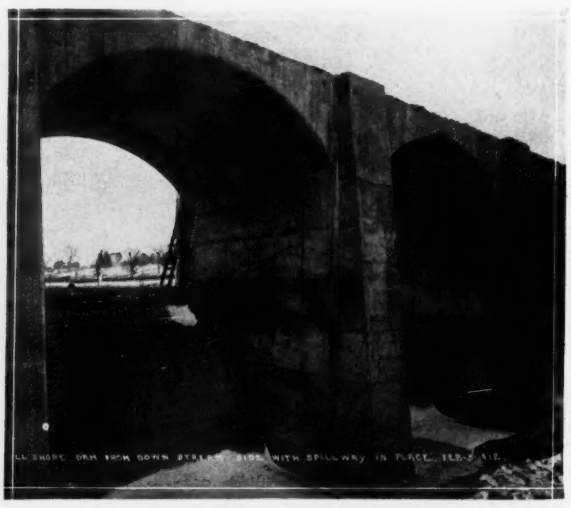


FIG. 3. SHORE END OF DAM FROM DOWNSTREAM, SHOWING COMPLETED SPILLWAY SECTION

for holding in reserve the surplus water so that no lack shall be had in dry months, and all work must be done without disturbing the navigation traffic which passess up and down the river.

But Mr. Cooper is a big man, mentally as well as physically, and big obstacles only arouse him with big determination. It was no discouragement to him that he must form an artificial lake 65 miles long, a

mile to 3 miles wide and 35 ft. deep, and that he must be able to control the floods which during the last spring have cut away river banks and flooded thousands of square miles. Such an obstacle did not mean to him that he was to stop, only that he was to find means to secure the necessary result. And so he went out to interest capital, and to prove that power could be sold in competition with cheap coal of the region, he made contracts for the delivery of 60,000 hp. in St. Louis at a price which would give a reasonable profit, if the power was produced from the development, the sale being made before the development was even started.

The project included not only the dam and power house, which in themselves were problems enough, but provision must be made to raise the tracks of the C. B. & Q. R. R. for 14 miles where they would be overflowed by the new water level, new roads must be constructed on each side of the river, farms and towns which would be destroyed must be secured and, in return for the right to flood the present government canal, a new lock must be constructed as wide as any on the Panama Canal and of higher single lift. And all this must be done by a private corporation, with private capital and without government backing. But all obstacles have been overcome except a few which in contrast with those already met and conquered seem of little difficulty.

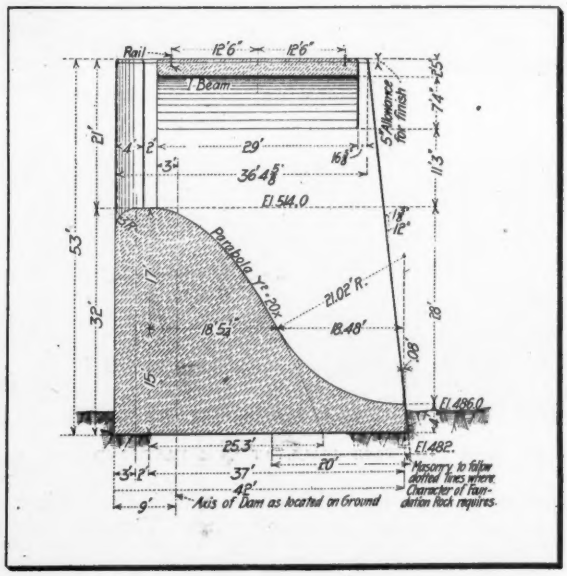


FIG. 4. SECTION OF DAM THROUGH SPILLWAY

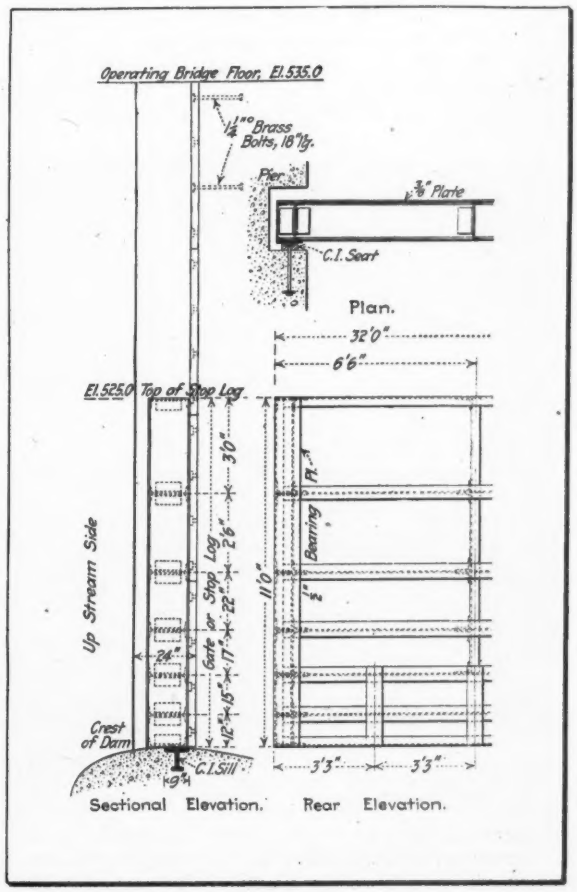


FIG. 5. DETAILS OF STEEL GATES ABOVE SPILLWAY

Public Benefits

THAT the company, under Mr. Cooper's direction, has taken a large view of its responsibility to the community is indicated by the fact that out of 800 different persons with whom negotiations for land rights were carried on, only a half dozen have claimed that the terms offered were other than entirely satisfactory. In the matter of new roads, the company donates the right of way through all the property it owns for boulevards built according to the latest and best methods from Keokuk to Montrose, in Iowa, and from Nauvoo to Hamilton, in Illinois, upon the shores of the lake, and pays $100,000 towards the cost of such boulevards. To safeguard navigation, the islands, which will be flooded by the new water level, are being cleared of timber so that no dead trees will be left to form dangerous snags. This has involved cutting over 3000 acres, the timber being used for lumber where possible, and the wood given to the nearby residents who would take it away.

Low lands between Fort Madison and Burlington have heretofore been subjected to overflow at flood stages of the river to the extent of over 30 sq. mi. and as only 2/5 of this would be affected by the new water level, the proposition was made and has been worked out to install a drainage system which will give the remaining 3/5, or 12,000 acres permanent freedom from floods; in other places 10,000 acres more will be drained so that in the end more tillable land will be available than before the building of the dam.

"Some Chunk of Concrete"

CONSTRUCTION immediately at the dam involves the dam proper, the power house, the locks, a dry dock, a sea wall for protecting the right of way of the railroad, and an ice fender to prevent ice from flooding the fore bay, the total making a great block of concrete 2½ miles long. The sea wall, which has only the function of protecting the relocated railroad track will be 1110 ft. in length, 45 to 73 ft. in height. This construction will involve about 650,000 cu. yd. of concrete calling for a like number of barrels of ce-

ment and 300,000 cu. yd. of sand. The horsepower in the final development will be some 300,000, and will be transmitted at 110,000 volts to St. Louis, Quincy, Burlington and possibly even to Chicago, the right of way purchased for the transmission lines being 100 ft. wide to insure safety.

Preparation for the construction was necessary on a big scale commensurate with the bigness of the undertaking. The construction plant is only a temporary affair, but it involved the laying of 16 miles of standard gage railroad; the purchase of 16 locomotives, 142 cars, 9 concrete mixers with a capacity of 2500 yd. every 10 hours, 7 10-ton stationary derricks, 50 miles of iron pipe, much of it 1 in. but more than 12 miles over 3 in., 44 steam boilers with total horsepower of 3755, centrifugal pumps with capacity of over 46,000,000 gal. a day and the collection and organization of a force of 1500 men. The construction plant alone cost $1,000,000 and the estimate for the entire cost is $25,000,000, involving an interest cost of $3000 a day, so that rapidity of work, in order to secure early completion, was of great importance. So thorough have been the plans of the engineers, however, that up to date the progress of the work is ahead of that figured on and the cost of construction is below the estimate.

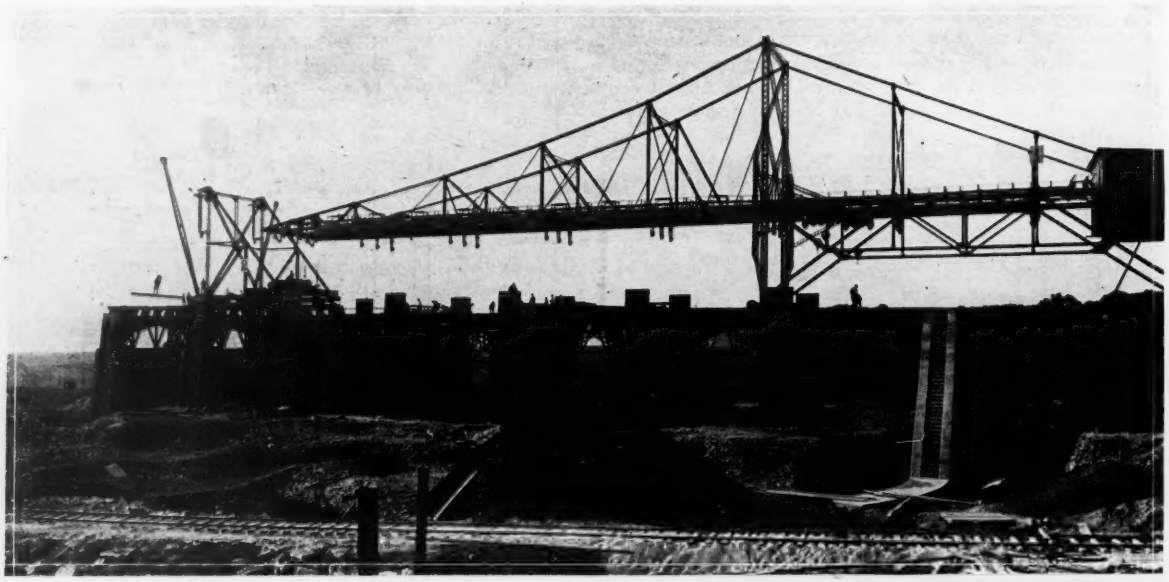


FIG. 6. TRAVELER CRANE AND ARCH FORMS STARTING FROM THE WING WALL AT THE EAST END

The Dam

FORTUNE favored the engineers in making the bluffs on each side of the river nearer together at the foot of the rapids opposite to Keokuk than at any other point in the entire length and in giving the bottom of the river a rocky character of hard blue limestone, giving an ideal footing for the dam and other work. Construction was attacked from both ends at once, the dam being thrown out from the Illinois side and the power house and locks being started on the Iowa side. The dam proper across the bed of the river has a length of 4278 ft., an east abutment of 290 ft. and a west abutment of 81 ft., while the width at the bottom is 42 ft. and at the top 29 ft. and the height of the structure 53 ft. The dam is constructed in sections, each spill way section being 30 ft. in length and 32 ft. high surmounted by an arch, the piers being 6 ft. thick with a height of 21 ft. above the top of the spillway. On top of these arches is carried a roadway 29 ft. wide, and the openings between piers can be closed by gates so that the water level can be raised above the top of the spillway to the springing line of the arch in each opening. These gates will slide in grooves in the sides of the piers and a derrick running on a tramway upon the bridge will operate them, giving a total length of spillway of 3570 ft. to take care of the flood water.

In order to secure a solid base for the dam the foot is let into the solid rock some 4 ft. or more according to the contour of the river bottom which is tested at intervals by 4 in. drill holes sunk to a depth of about 30 ft. Each hole is tested by pumping water and compressed air into it to determine the presence of any seams or fissures, which connect with the surface or connect the holes with each other. The dam proper is of gravity type, each 30-ft. section being independent and self-sustaining, although each section is keyed to the piers by grooves to give water tight joints.

At the east end is the abutment of solid gravity section, extending from bed rock in the bluff to the end of the spill way and having a wing extending down stream to prevent erosion and also to act as a retaining wall for a rock and earth fill which will be put on the down stream side of the abutment and made to conform to the slope of the wing wall. No steel reinforcement is used at any point, the up-stream side of the dam being vertical and the down-stream with a curved crest and ogee to conform to stream flow.

Normally, the water level will be 24 ft. above tail water as controlled by the spill way, and this may be increased to 35 ft. by the gates in the arches. These gates are steel panels 11 ft. high and 32 ft. long sliding in grooves in the piers, the down-stream sides of the ends resting upon cast-iron plates in the grooves.

Time Saving

IN building the dam, steel forms have been used to faciliate construction and as there are 119 sections to be built it has been possible to put a large expense into forms and still to save more than their cost in the expense of construction. Two traveller cranes are used on top of the completed portion of the dam to change forms and deposit the concrete. The rear traveller takes down the forms and loads them on cars which run on a track parallel to the work and the forward traveller sets up the forms which can be done in about 6 hr. each, and delivers concrete to them. A double track railroad runs from the crusher and mixer plant on the east shore along the top of the dam to deliver the concrete to the travelling crane, which has a capacity of 10 tons on each trolley. By careful use of the transit and level a pedestal is built on the rock bottom for a form, and a cast-iron plate placed on the pedestal. This has dowel pins which engage with holes in the bottom of the end form, insuring perfect alignment of the different sections.

Materials for the concrete are found near at hand. The stone comes from a quarry about 300 ft. away on the bluff, where it is blasted out, scooped up by a 100-ton steam shovel, which turns it over to dump cars which deliver it to a revolving crusher, and this to belt conveyors which carry it to a storage bin.

Sand from the mouth of the Des Moines River, 2 miles away is brought in trains and this with the crushed stone and the cement are mixed in a plant on the hillside which is automatically supplied by gravity from big bins above and delivers the mixed concrete by gravity to the trains which carry it out to the waiting forms.

Far out ahead of the dam reaches the coffer dam which holds back the waters of the deep river while the engineers construct the barrier which is to conquer it. Up stream the coffer dam is made of timber cribs, the spaces between filled with timbers and the whole sealed with earth. Down stream, an earth fill serves to prevent water from backing into the space where the dam is to rest.

In building the dam, the arches and piers are first put in place and when these are completed the spill ways are built up between. This is done in order to avoid the tremendous power which the river would have against the completed section if the spill way were built to final level as the work goes along. After the piers are all completed, temporary walls will be built on up-stream and down-stream sides of each pier and the forms built in to give the spill way section. Each spillway will be raised 5 ft, at a time across the entire width of the river and the operation then repeated, thus gradually raising the entire level of the pool above. The last layer will bring the section up to the full height of 32 ft.

Expansion Cushions

SUCH a mass of concrete as is here involved will, of course, contract with cold and expand with heat, the variation of temperature at this point running from 27 deg. below zero to 109 deg. above. To provide for this, a layer of tar paper is set on edge in the middle line of each pier extending from the floor of the viaduct down to the middle of the bottom of the arches, this paper acting as an elastic cushion against which the 36-ft. length of concrete in the roadway may expand. After the paper has rotted out, an interval as wide as the thickness of the paper will remain between each 2 sections at the top of the dam structure. In the large mass of concrete involved in the spillway, there will be but little temperature fluctuation at the center so that it is necessary to provide the paper cushion only at the surface and for a certain distance into the mass, this paper being placed between one end of the spillway in each span and the pier.

Eight sections of the arch forms are in place at one time, a form being allowed to stand about 5 days for the concrete to set before it is removed from the completed arch. Thus the forward travelling crane, 90 ft. of which rests on top of the completed dam and 150 ft. of which extends out over the advancing forms is continually pushing its way forward at the rate of some 60 ft. a day.

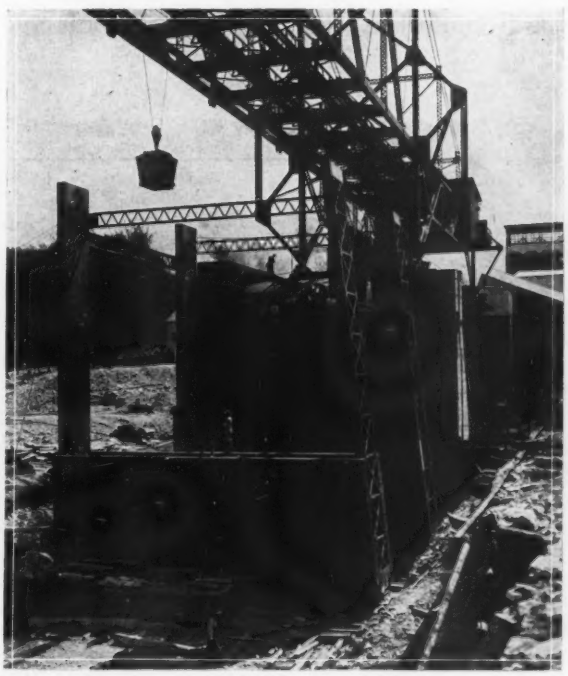


FIG. 7. ERECTING THE FORM AND PLACING CONCRETE FOR A PIER AND ARCH

It might be thought that building up in sections there would be difficulty in making them line up, but so careful has been the provision for accurate work that any section of the dam, which stretches the greater part of a mile is found after completion to be not more than a few hundredth's of an inch out of line.

The Lock and the Dry Dock

BEFORE they would give consent to the undertaking of this project, Congress and the War Department imposed the condition that there should be deep water for boats for 65 miles above the dam, that there should be a lock at the dam, sufficient to care for all the river traffic and a dry dock to replace the one now existing. All these conditions are being more than met by the Mississippi River Power Co., as the lock under construction is one of

the largest in the world, the dry dock is the largest in fresh water and the back flow produced by the dam will give for more than 65 miles up stream the 8 ft. of depth which the Government maintains from St. Paul downward. The present cost to the Government is $40,000 a year to operate the canal and the locks while the power for this operation will in future be furnished free by a separate plant, the only expense to the Government being for labor to operate the lock and dry dock. At the dry dock there will in reality be a boat-building plant as a considerable shop is maintained there.

In order to clear the space on which the lock and other works at the west end of the improvement are being built, a coffer dam was placed surrounding the entire area. This dam is built of cribs, 24 by 16 ft. placed 12 ft. apart and spaces filled with square timbers, the outer wall sheathed with planks and sealed with earth and faced with rock fill. The bot-

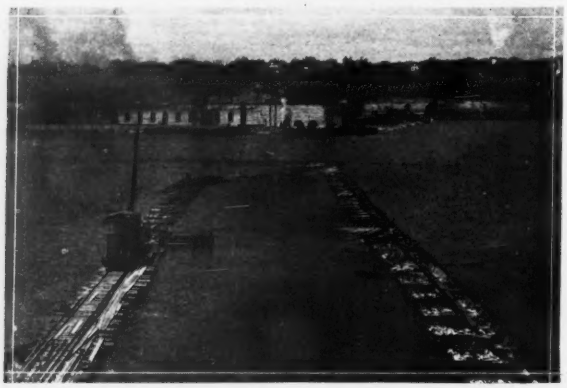


FIG. 8. COFFER DAM; PIONEERING FOR THE CONCRETE

tom is shaped to fit exactly the river bed, a raft of the same size as crib being anchored over the place where the crib was to sink and careful soundings made all around the edge of the raft. The bottom timbers were then shaped to conform to the surface of the river bottom. As the plan has worked so well there is but little seepage into the works. The large dam enclosing the power house and lock site contains about 34 acres of unwatered river bottom, the dam extending along 3 sides of a rectangle, the fourth being the stone dike which forms the eastern bank of the government canal. Figure 9 gives an idea of the north end of the unwatered section into which the power house is being built.

The lock extends south from the lower end of the power house between that and the shore line at Keokuk. Excavation for the bed of the lock was done by blasting and the rock thus taken out was crushed and used in concrete for the power house and the dam. The lock proper is 110 ft. wide and 400 ft. long, and each gate is a steel truss 115 ft. in length and 50 ft. high. The lift in the lock is 40 ft. and 8 ft. of water is always carried over the sill of the lock. The walls are 52 ft. 4 in. high and vary in thickness from 33 ft. at the bottom to 8 ft. at the top. In order to make a causeway on top of the lock wall; inset arches are sprung, on which it is carried.

The present canal is 9 mi. long and 2 hours are consumed in passing. It will require from 10 to 15 min. to pass through the new lock, thus making a considerable saving in the time of river boats passing up and down. To fill and empty the locks, a gridiron of culverts, one of which is seen in Fig. 10, is placed in the bottom of the lock, the mains being under the walls and cross bars of the gridiron under the lock floor at regular intervals. The largest culvert is 13 ft. in diameter and the smallest 6 ft. The culverts are of concrete cast around steel linings, the latter being necessary because the high water pressure and the velocity would scour away the concrete if it were not protected by steel.

Alongside the lock on the west will be located the dry dock which is 150 ft. by 463 ft., the west wall of the lock forming the east wall of the dry dock. The site of the dry dock will be that now occupied by the Government canal and lock, hence, the dock will be the last thing built in order to avoid interference with navigation.

All this great construction will be given without charge to the government when completed in return for the right to install the dam and power improvement in the river which is a part of the navigable waters of the country. The improvement, together with the fact that 8 ft. of water will be available for 65 miles above the dam for rapid navigation by boats where heretofore it was necessary to travel carefully and slowly has a value which is estimated at from 5 to 10 million dollars.

The Heart of the Plant

AND the reason for all this great construction is the power house which is located near the Iowa shore. As shown in Fig. 1 this extends almost parallel with the river, the area between the power house and the bank constituting the forebay from which water flows through the turbines. The natural curve of the shore, together with the slant in connection with the power house gives the effect of a funnel and facilitates the flow of water through the turbines at the far end of the power house. The flow through the power house will be almost at right angles to the river turning into the tail race which runs parallel with the river bed on the river side.

Two parts make up the power house, the substructure, which is merely a part of the dam and the superstructure which contains the generators, transformers and switching apparatus. Hydraulic machinery is located in the substructure and is being built by Chief Engineer Cooper and his force, which handles the hydraulic installation, the dam, lock, dry dock and sea wall and other civil engineering construction. The electrical outfit and superstructure are being built by the Stone and Webster Engineering Corp.

When completed, the installation will comprise 30 units with turbine and generator on the same vertical shaft. Half the entire installation is now being built, the rest of the substructure being carried to only part of its full width as it was found cheaper to build a new coffer dam when it is desired to complete the other half of the power house than to pay the interest charges on the additional construction until the time when it shall be required for use.

When completed the power house will be 1718 ft. long, 132 ft. 10 in. wide and 177 ft. 6 in. high from the lowest point of the tail race to the highest point of the roof. The substructure will be 70 ft. high to the generator floor and 78 ft. high to the floor which

carries the transformers. From generator floor to top of the roof the superstructure will be 107 ft. 6 in. high, having 2 stories, each with very high ceilings to give clearance for the travelling cranes, one of which will be capable of lifting an entire turbine with its shaft and carrying it into the machine shop in the north end of the power house.

The entire construction of the substructure is monolithic concrete, while the superstructure is reinforced concrete walls and columns, surmounted by a steel truss roof, as shown in Fig 11.

Twenty-five feet below the surface of the limestone bottom of the Mississippi rests the foundation of the power house and the tail race will be blasted out to this depth in order to gain fall. The entire area of the tail race, a half mile long and nearly 150 ft. wide, is blasted out, and excavated by means of steam shovels, the rock being converted into concrete and used for the power house walls.

As the Water Flows

WITHIN the great concrete ledge which forms the substructure of the power house are found the chambers in which the turbine units are to be located; also the passages through which the water rushes to the wheels and drops away from them, the passages through which is secured entrance to the wheel chambers, the ice shutes through which any floating ice or obstruction may be shot from the forebay into the tail race, and the gate chambers, in which are placed the head gates for controlling admission to the turbine passages.

FIG. 10. LOCK WALLS UNDER CONSTRUCTION AND CULVERT SYSTEM IN THE BOTTOM

Following the water in its course down the river, it passes through the great arches in the ice fender, a curved wall, stretching from the power house toward the western shore 2325 ft. long of concrete and with a 300 ft. floating boom which closes the gap during winter and is opened during the season of navigation. This fender has 29 spans, with 10-ft. piers and 60-ft. openings, the top being 5 ft. above high water and the top of the openings 4 ft. below low water, thus giving a wall which catches the floating ice and prevents it from entering the forebay. The bottom of this wall is 16 ft. wide and the top 8 ft. wide, making a substantial construction against the force of any ice jams that might form. The floating boom goes down 5 ft. into the water, thus forming an effectual barrier against the ice.

Some question has been raised as to what effect the ice will have when it goes out of the river in the spring. Those who have witnessed the terrific power of an ice jam may well wonder what works of man can stand against such force, but it must be remembered that with the formation of a quiet pool 1 to 3 miles in width and 60 miles long, there will be no rapid rush of ice down the river as has been the case in the past, but the ice resting against the ice fender and power house and across the river against the stop log gates will remain a quiet mass until it melts and goes down as water instead of going down with a rush in the form of great irrisistible projectiles.

Beyond the ice fender and the boom is the quiet forebay from which the water strains through the screens or trash racks to the head gates and from them swirls through the scroll openings to the turbine. These scroll openings are divided by partitions so that water will pass to the wheels in the proper direction and without eddy currents in 4 equal parts. This plan was adopted, as the results of some experi-

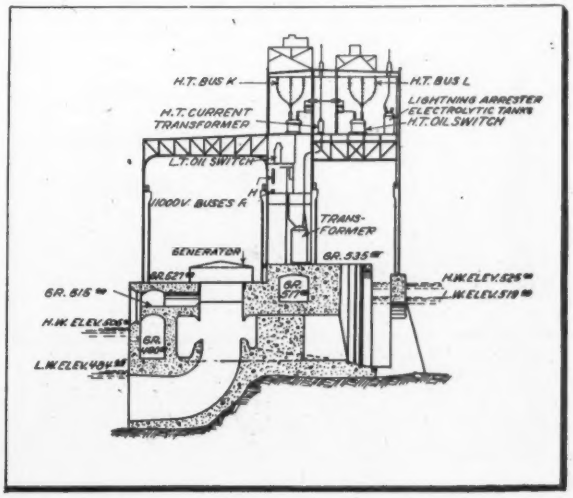


FIG. 11. SECTION THROUGH POWER HOUSE SHOWING TURBINE CHAMBERS, DRAFT TUBES, GATES, ETC.

ments have shown that with the open passage to the wheel gate, water was flowing away from the turbine at some points instead of toward it, thus wasting power. As shown in Fig. 11, the draft tube drops straight from the turbine and then curves into a great oval which discharges into the tail race. Wooden forms are used at all points in casting the chambers in the substructure as the forms are intricate and there is not enough duplication to pay for the making of steel forms.

Travelling cranes are used in all parts to carry the concrete and deposit it at the point wanted, these cranes rising from legs which rest on the rock floor of the power house site on both sides of the structure. This whole forms a railroad of about 125-ft. gage, the travellers moving along the length of the power house to any point desired and the cross carriages running back and forth to dump the concrete at the point where work is being carried on.

A head gate is provided for each of the 4 openings shown in the scroll, Fig. 12, the gate opening being 22 ft. high by 7 ft. 6 in. wide. The turbines are so located that 22 ft. of the head is above the center of the turbine runner, while the rest of the head is taken care of by the draft tube. Each unit is like every other unit, with the exception of the exciters, which are, of course, smaller. Where it leaves the turbine the draft tube is 18 ft. diameter and where it discharges into the tail race, the ends are semicircles,

22 ft. 8 in. in diameter, joined at top and bottom, by straight lines giving a total horizontal width of 40 ft. 2 in.

Above the substructure rises the reinforced superstructure walls and the columns which are reinforced by rods inside and tied by these reinforcing rods to the concrete substructure. Generator rotors are carried, of course, by the same shaft as the turbines and the stationary part is carried on the concrete floor. Transformers also are carried in the same way, but the bus bars, oil switches and lighter apparatus are carried on a second floor.

Generating Units

THESE giant units will consist of turbine and generator, on a single vertical shaft, 25 in. in diameter and running at 57.7 r.p.m. Because of the leisurely speed, the size of the generators will be distinctly big,

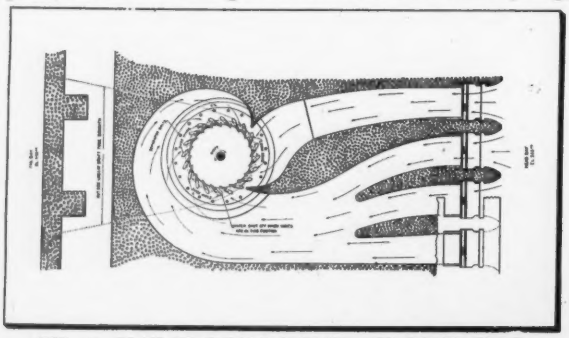


FIG. 12. PLAN OF SCROLL INTAKE AND DRAFT TUBE

the diameter being 32 ft. and the height 12 ft. and the total weight of each machine being over 600,000 lb. Dismantled and ready for shipment each generator forms a train of 15 to 20 freight cars, and the 15 units, for the first half of the installation, would make up a train 4¾ miles long. Even at the slow speed, the great diameter of the rotors gives a high velocity of circumference, which will be travelling at 52½ miles an hour. These generators will furnish alternating 3-phase currents at 11,000 volts, which will be stepped up by water-cooled transformers to 110,000 volts for transmission to distant points. The field revolves on the outside of the machine, the armature being stationary inside and the height of the outside is such, that a 6 ft. man could carry his 5-ft. 3-in. wife on his head and she would barely reach the top of the machine. Seventy-five hundred kilowatt is the rated capacity of each unit and 10,000 hp. that of each turbine. Exciting current is furnished by alternating-current motors, driving direct-current generators, the operating current being supplied from a 2000-kw. water-wheel-driven generator, of which 2 are to be installed. In case of emergency, the overload capacity of the turbine is 13,500 hp., or 10,000 kw. At rated load, the efficiency of generators is specified at 96 per cent.

Turbines

IN these rest the driving power, which must keep the 600,000-lb. top spinning on its axis and sending out for 150 miles around the energy which is now wasted in the tossing and swirling of the river current. And it is no small problem to support and regulate such a top. The entire weight must be carried on a single bearing, the revolutions must be governed and the lubrication must be adequate.

To carry the weight of this great mass a base ring is built into the concrete, as shown in Fig. 13. The concrete columns there shown are merely for construction work and are removed before the turbine casings are placed. Turbines furnished by I. P. Morris & Co. and the Wellman-Seaver Morgan Co., are carried at the bottom of liners, these liners being steel cylinders surrounded by concrete. At the top and bottom of each line are rings which support the entire weight of the power units.

These liners are of ¾-in. steel, 21 ft. 3 in. diameter and each weighs 212,000 lb. The cast-iron rings at the top and bottom weigh 100,000 lb. each, and the total weight supported is about 962,000 lb. On account of problems in transportation it was necessary to make each ring in quarters, 2 quarters, or a half ring making a load for a flat car, and special routing on the railroads being required to secure necessary strength of bridges on the route. One of the liners, in the course of building, into the concrete is seen in Fig. 14.

From the lower bearing ring a steel cone reaches upward to the middle of the height of the pit liner, where the thrust bearing is installed. This has a surface some 6 ft. in diameter, carried on the stationary casting with a similar surface carried by the shaft and revolving above. The 25-in. shaft to which this thrust bearing is fastened, is coupled near the floor level to the generator shaft and carries on its lower end the runner of the turbine. As may well be imagined, the great weight carried on this thrust bearing makes necessary special means of lubrication, and they

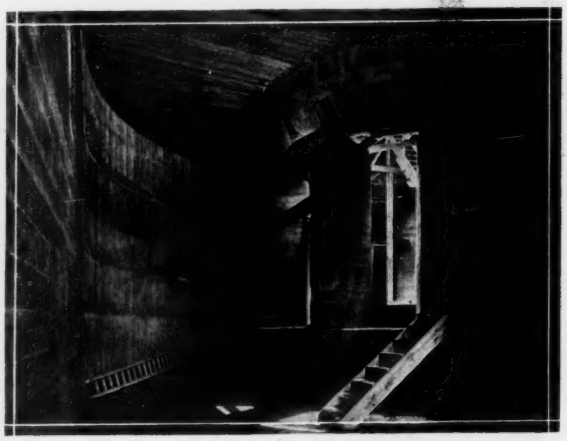


FIG. 13. INTERIOR OF INTAKE, AND TURBINE CHAMBER

are installed in duplicate to prevent the possibility of break down. Carrying all the weight on one bearing increases the lubrication difficulty, but avoids any trouble from lining up 2 or more bearings.

Oil at 250 lb. pressure per square inch will be forced between the disks of the thrust bearings so that the revolving weights will be floated on this film of oil. If for any reason the oil supply gives out, a set of steel rollers will come into play which will run in an oil tight chamber surrounding the bearings. When the oil film under proper pressure is holding up the load, the rollers do not touch. If for any cause the oil film should fail, and the upper face drop by the thickness of that film, that face will rest on the rollers, thus giving a roller thrust bearing.

Mr. Cooper is entertaining hope that the roller bearing will be able to handle the load without the use of the forced pressure oil and that the latter will be used only for emergency working.

In procuring the turbines for this plant, no expense was spared to get the highest possible efficiency. When it is considered that on the efficiency of the wheels depends largely the output of the plant and the cost of the wheels is about 6 per cent of the cost of the development, it will be seen that no effort is too great to get the most possible out of each wheel. Competitive study and design by the best turbine engineers of Europe and of America resulted in a composite design of the Francis type, which will give an efficiency of 86 per cent, the highest ever shown in tests at the Holyoke plant. Average practice of the day is shown by government investigation to be about 75 per cent, so that it may be assumed that a distinct advance in turbine design has been secured.

Twenty buckets are used on each wheel, the entire number being in a single casting, which carries also the hub. The runner is 15 ft. 2 in. in diameter at the band and weighs 130,000 lb. The buckets are designed to respond to the inward and downward flow of the water and mounting of the runner at the bottom permits that the only parts in the water are the runner, the gates and the steady bearings, the regulator parts and all auxiliary mechanism of the turbine being mounted above the water level, so that they can be inspected at any time from a ladder on the inside of the pit liner.

Water flows to the runners at the velocity due to the head of 32 ft. and leaves through the draft tube at a velocity of 14 ft. a second, which by the enlargement at the end of the tube is reduced to 4 ft. a second when it enters the tail race.

Control of the runner speed is by manipulation of the 20 guide vanes, each of which is 6 ft. 1 in. in height.

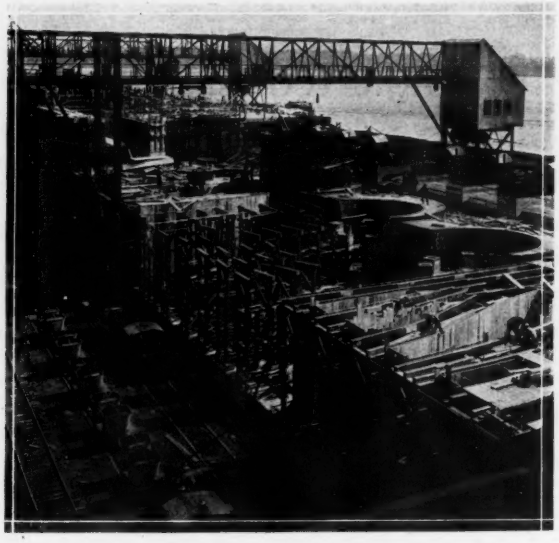


FIG. 14. POWER HOUSE CONSTRUCTION; WHEEL PIT FORMS; PIT LINER; TRAVELING CRANE AND BUCKET TRAIN

These are pivoted, and controlled by 2 hydraulic cylinders, operating under oil pressure through pistons, connecting rods and cranks, and in turn controlled by a sensitive governor located on the floor of the power house. Movement of the governor controls the pilot valve, which in turn controls the flow of oil to or from the pistons that move the gates in the turbine casing. The velocity of water entering the guide vanes will be about 7 ft. per second, the amount of water entering being controlled by the position of the vanes.

Distribution of Power

AS previously mentioned, the generator will deliver current at 11,000 volts and for long distance transmission this will be stepped up to 110,000 volts, 11 9000-kw. transformers being installed for this purpose. Ultimately there will be 28 transformers of this capacity. Two lines for 110,000 volts of 36,000-kw. capacity will carry current to St. Louis, where 60,000 hp. has already been contracted for, and 2 similar lines of 27,000-kw. will run to Burlington. For the time being, the Burlington lines will probably be run at 11,000 volts until the industrial demand warrants the use of a higher voltage. Provision is also made for a large number of 11,000-volt local lines and for at least 4 additional 110,000-volt distribution lines.

Unlike many other plants, automatic devices have been almost entirely omitted, leaving the discretion of the operator to handle any critical condition that may arise. This will necessitate the employment of a larger number of operators than usual and the

FIG. 15. GENERAL ELECTRIC GENERATOR FOR THE KEOKUK PLANT

switchboard has been laid out with this point in view, so that there is one individual switchboard for each 3 or 4 main generators with their outgoing lines and auxiliary apparatus. In order to put everything possible within reach of the operator, and also because of the large number of devices, the main switchboards will be built by combination bench, and vertical type, with all control apparatus mounted on the benchboard and its sub-base. Regulators, indicating and recording instruments and the calibrating devices will be located on the vertical board directly in front of the bench with about 3 ft. between to allow room for calibration and adjustment of the instruments without danger to operator.

In normal operation, it is intended to supply certain transmission lines from certain generator units without running the whole station in parallel, but on account of the great capacity of the station it was found necessary to provide protective reactance in the busbars, in case it should be necessary to throw parts of the station in parallel. As further protection, the generators are provided with inherent reactance to limit the short circuit current to a reasonable figure.

Most careful attention has been given to the design of the oil switches, those on the 110,000-volt circuits being of the well-tried motor operated type with a few special features to make them adaptable to a station of this magnitude. These switches are operated by solenoids and have certain special features, one of these being to make the switches good for over 2000 amperes for a short period. Five benchboards are included in the first installation, each board controlling 3 or 4 generators and one operator taking care of each bench. A number of auxiliary boards will be installed for the control of the auxiliary apparatus. Switches on the circuit breakers are controlled from 125-volt storage batteries which also serve for emergency lighting about the station.

In order to have all parts completed at the same time, the transmission line to St. Louis is now under

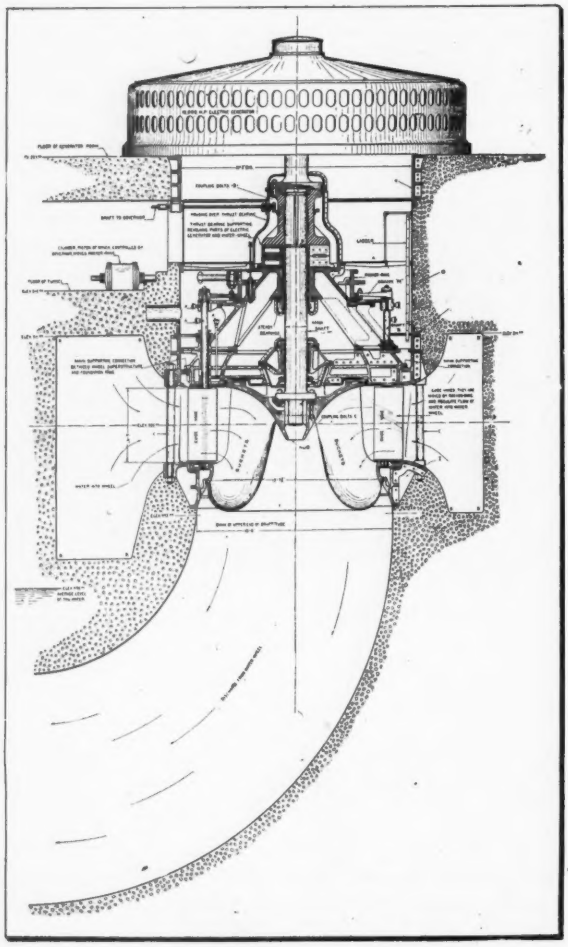


FIG. 16. SECTION THROUGH TURBINE, PIT LINER, SCROLL CHAMBER AND DRAFT TUBE

construction and recently a permit has been taken out for the erection of a $75,000 substation at Gage Ave. Heights, in St. Louis, to be of steel frame construction, fireproof in every detail.

Work is being pushed rapidly, and while the first plans called for the completion and operation of the plant by July 1, 1913, at the present time, Mr. Cooper thinks that operation will be commenced by the first of May.

And here in the largest power house in the world, the planning and performing of the trained corps of engineers, under Mr. Cooper's direction, will have wrested from the mighty Mississippi River, "Father of Waters," the greatest amount of energy ever harnessed for the service of mankind in any one place

With the entire installation of generator units in service the plant will develop 3 times the power now used in the state of Iowa, more than is used in the state of Missouri, and 1/3rd as much as is used in the state of Illinois, including Chicago, and all the surrounding cities. And here, figuring on a conservative estimate, the force, which in years past and for countless centuries has been wasting itself, will furnish for the service of mankind a power equal to the burning of 1,800,000 tons of coal a year and that without the sweat and toil required for mining and without reducing in any way the natural resources of the country.

It is, of course, not a philanthropic enterprise, but it must be recognized that such a development as this, even though it may bring to those who have accomplished it some return in this world's goods, is nevertheless a great blessing to humanity and the thanks not only of present, but future generations are due to those who have carried it through to a successful completion.

The staff which has been engaged in the construction work has at the head Mr. Hugh L. Cooper, the moving spirit of the enterprise, and assisting him has been in charge of the work on the Illinois side, D. P. Cooper, on the Iowa side, H. T. Herrick and in charge of the mechanical work for all divisions, B. H. Parsons. To them our thanks are due for assistance, data and illustrations.

HONEYCOMBED ICE

IN a discussion before the Southeastern Ice Association, the question was raised as follows: Hard water containing lime and magnesia when frozen into plate ice becomes honeycombed, though stored in a room refrigerated to 30 deg. or less. What is the reason for this, and what means are possible to prevent it? Soft water when made into plate ice will keep and not honeycomb.

Professor Sparks stated that this honeycombing was due to magnesia, not to the lime, and that experiments had shown that if the magnesia was over 6 grains to a gallon of water, the ice was opaque on the outside and honeycombed frequently; lime, even as high as 20 grains per gallon, produces no such effect. He added that when trying to use raw water for can ice he thought that there would be a lot of trouble if the water was charged highly with magnesia, for in all such cases the ice will be cloudy and there will be trouble with honeycombing. The magnesia can be taken out with caustic lime. Down in Texas they have sulphate of soda in the water, which is worse as there is no known way of taking it out, and it also will produce opaque ice and honeycombing.

Mr. Holcombe stated that his firm recommended a simple purifying system which will be inexpensive to operate and which will eliminate all impurities except the sulphate of soda at a trifling expense of somewhere near 2 or 3c a thousand gallons.

SETTING UP TURBINES

Proper Foundation and Methods of Securing Proper Alignment

By W. A. London

CORRECT ALIGNMENT OF TURBINE MACHINERY is of the greatest importance and too many precautions cannot be taken to insure as near as possible ideal conditions when the machine is originally erected. We have only to think for a few moments of the conditions existing when 2 shafts, not exactly in line, are coupled together and run at turbine speeds, to appreciate the difference that is bound to exist in the operation of the machine when in perfect alignment or otherwise.

In the previous article we laid particular stress on the necessity of good foundations to eliminate possibility of their sinking, which in turn would affect this alignment.

The lining up of a turbine set is by no means a difficult operation, and while the builder feels much safer in sending his own man to do this work, there

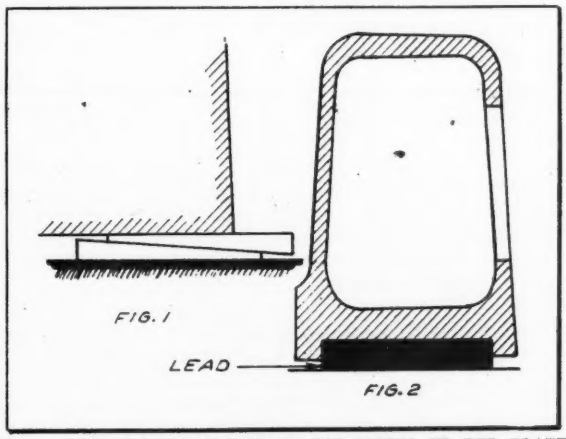


FIG. 1. USE OF DOUBLE WEDGES FOR LINING UP BED PLATE
FIG. 2. USE OF LEAD WITH STEEL GIRDER FOUNDATION

is no reason at all why an engineer experienced in the erection of steam engines should feel himself called upon to consult a so-called turbine expert to show him how to do this work.

Horse Sense Needed

THE old idea that existed in the minds of so many engineers inexperienced with turbines that there is something uncanny about them requiring nothing short of a wizard to start them up is fortunately fast dying out, and turbines erected by an engineer of the old school on general "horse sense" principles are in many instances far ahead of those erected by the up-to-date turbine specialist.

Were the erection of machines always left to engineers, (turbine or otherwise), there would be little use in enlarging on this subject, but nowadays, unfortunately, it is often the custom to turn the machine over to the most inexperienced class of help and expect, on completion of the erection, a first class running outfit. This condition is of course, more prevalent in small outfits than in the larger installations.

The standard methods employed in the erection of engines, shafting, etc., apply equally well to turbine work, but in addition to these there are a few kinks and short cuts peculiar to turbine erection.

Before describing these let us go back to the point when the machine is ready for placing on the foundation, so as to follow the work through in its chronological order.

The method employed in the erection of the machine varies not only with different handling facilities but also with the size of machine and make of foundations.

Grouting In

LARGE machines are, of course, shipped piecemeal, in which case the bedplate is first placed on the foundation and lined up from the machined surface. Plenty of double wedges should be employed for this lining up, (See Fig. 1.) If the foundation is of solid concrete, it is safe to grout in the bedplate before placing in position the turbine parts proper, but when a

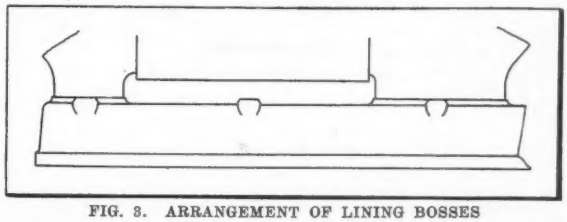


FIG. 3. ARRANGEMENT OF LINING BOSSES

steel beam foundation is employed then as many of the parts as possible should be put in place before grouting. The necessity for this will be at once apparent when it is considered that the load is unevenly distributed along the bedplate, and the deflection of the foundation girders will vary. It should never be assumed that a cast-iron bedplate is sufficiently rigid to hold a machine in line if the foundations sag or settle.

With a steel girder foundation it is often customary to grout in with lead or zinc, as shown in Fig. 2. This makes a very satisfactory damping medium to prevent transmission of vibration along the floor. Whether lead, zinc or ordinary cement grouting is employed, the bedplate should always be well clear of the girders. With ordinary grouting, about ½ in. is considered good practice, and the grouting material generally recommended is 1½ to 2 of sand to 1 of

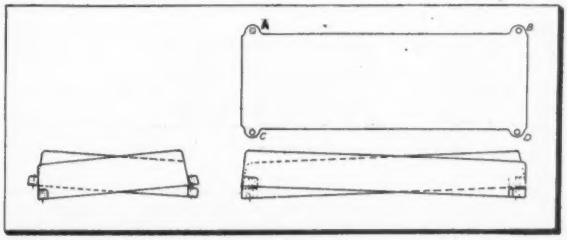


FIG. 4. DISTORTION OF BEDPLATE BY BOLTING DOWN AT CORNERS

cement. Where allowances for grouting are very small, it must be borne in mind that the above will not flow freely, and with very small clearances as rich a mixture as 2 cement to 1 of sand must be employed to insure a free flow of the grouting material all over the surface of the bedplate.

One other point; where possible, always let the grouting run well up inside the bedplate.

Some makers fit their bedplates with "lining up" bosses, as shown in Fig. 3. These may prove useful, if the bedplates are erected with those in line to begin with, as it is then a very easy matter to check up the alignment of the machine from time to time should there be any question as to the stability of the foundations.

Expansion Allowances

ONE other important point to be considered in the alignment of a complete turbine set is the difference of expansion that will take place between the turbine and the generator (or other end of apparatus).

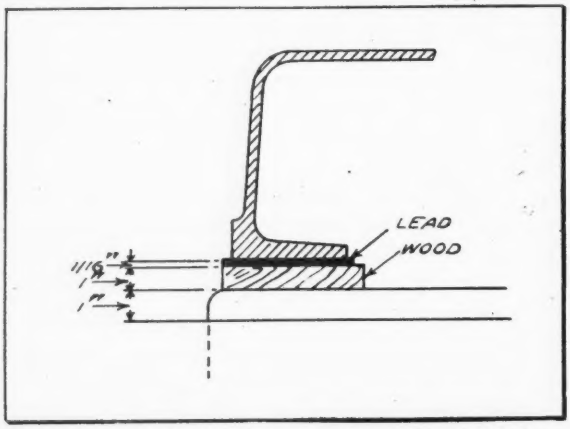


FIG. 5. EUROPEAN METHOD OF PREVENTING VIBRATION

It is impossible to give any rule for this, owing to the fact that designs of machines vary so largely. In machines where the turbine case is supported under the exhaust pipe, for instance, it is obvious that the casing will expand and the center of the machine rise more than if the case itself is suspended by pedestals not subject to steam temperature. It is obviously an easy matter to align a machine where this latter design is employed, as there will be little difference in height due to expansion throughout all the bearings, but where the turbine case is supported, as mentioned

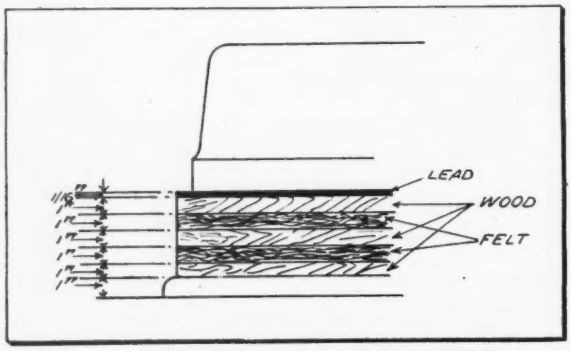


FIG. 6. WOOD AND FELT VIBRATION CUSHION

above, from the exhaust pipe, it is to be expected that the center of the turbine will rise in direct proportion to the temperature. It has been found from experience that the amount at which the generator (or blower, etc.) should be initially raised above the level of the turbine shaft when cold coincides very closely with the theoretical expansion of the turbine case. Where possible, the final alignment of the machine should always be made with the turbine case heated up to approximately operating temperature conditions.

Bedplate Alignment Not Enough

IN the erection of small turbine sets, the mode of procedure differs from that employed in the larger sizes, inasmuch as the complete unit is generally shipped in one piece. In this case, the bedplate alignment can be absolutely ignored, or rather should be left out of consideration altogether. Here again we often find the idea existing that because the machine has what appears to be a substantial bedplate if both halves of the unit are bolted to it, no matter what the foundations are like, the machine will be always in line. But it is beyond the limits of commercial possibility to design a bedplate of any length that is not easily distorted, particularly when holding down bolts are employed. Especially is this the case when bolts are fitted at extreme corners (see Fig. 4). The bed plate can be distorted to an absurd amount by, say, tightening bolts A and D and leaving B and C slack.

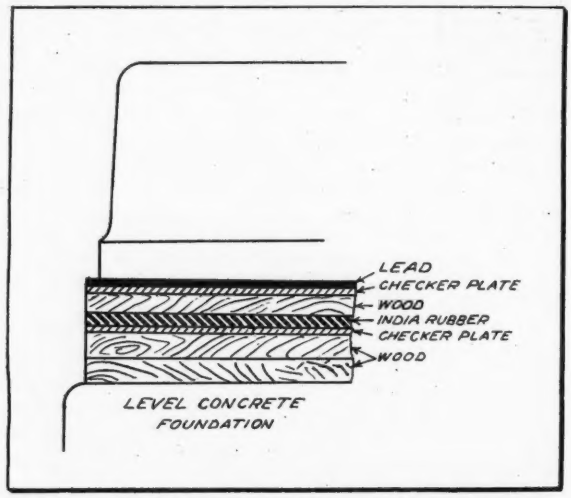


FIG 7. VIBRATION CUSHION OF LEAD, WOOD AND RUBBER

Opinions of the various makers differ as to the necessity of holding down bolts, both in large and small sizes. In large sizes, when the weight of the machine is obviously enough to resist distortion due to pipe strains, it is hard to see the necessity or even advantage of holding down bolts. But in the small sizes, when turbines are used for driving pumps, blowers, etc., having heavy pipes connected to them, it is a different proposition, and of course, with belted units holding down bolts, and substantial ones at that, are absolutely necessary.

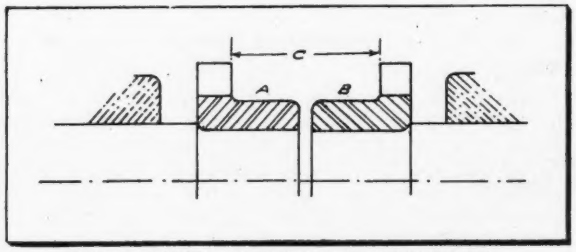


FIG. 8. LINING UP FROM A CLAW COUPLING

Damping Vibration

IN small generating sets, absence of vibration is of vital importance. The last article dealt with this point, and although in the average power house the "grouted in" method is satisfactory, there are installations where the smallest vibration or noise is objectionable. Damping mediums that are sometimes employed in installations of this kind are shown in Figs. 5, 6 and 7. Figure 5 is a very common Euro-

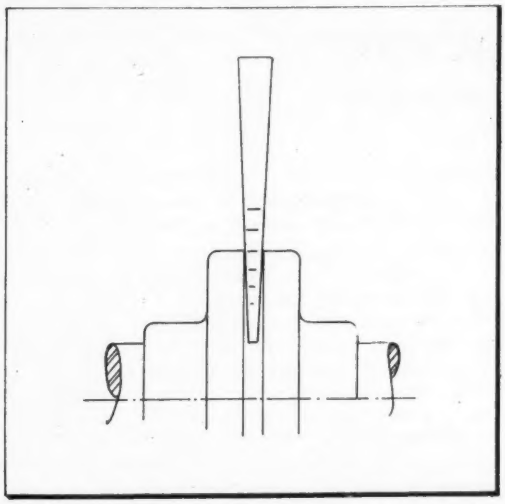
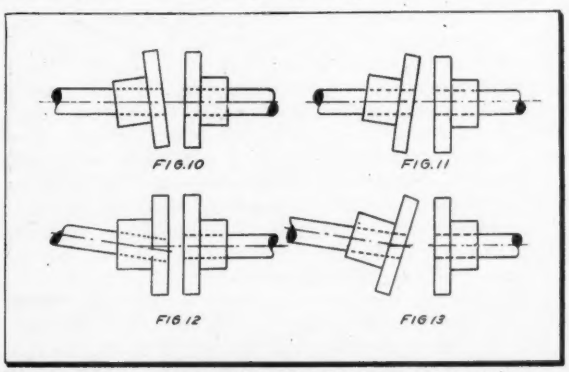


FIG. 9. USE OF TAPER GAGE FOR LINING FLANGE COUPLING

pean method and is employed here to some extent. In extreme cases, where this has not been sufficient to eliminate the transmission of vibration, foundations, as shown in Figs 6 and 7, have proved satisfactory. Of course, when foundations of this type are employed, no holding down bolts are used, and special care must be taken to eliminate any possibility of strain being thrown on the turbine from the piping, due to insufficient expansion allowances.

Lining Up for the Coupling

REFERRING to the original question of alignment, the machine being in place, the final alignment is taken from the coupling. In large machines employ-



FIGS. 10 AND 11. APPEARANCE OF AN UNTRUE FLANGE WHEN SHAFTS ARE IN LINE

FIGS. 12 AND 13. EFFECT OF LINING UP BY COUPLINGS OUT OF TRUE

ing the claw type of coupling, as shown in Fig. 8, a straight edge is applied along the surfaces A B, and the distance between the faces C measured by a micrometer at 4 places around the circumference; the halves of the machine are then turned 90 deg. together and the same measurements taken again, and so on through one complete revolution. Where flanged couplings are used, a taper gage performs the function of the micrometer (see Fig. 9), the same procedure being followed, including use of straightedge.

At this point it might be well to mention another erroneous idea that exists in regard to so-called flexible couplings, that because a machine is fitted with a flexible coupling careful alignment is unnecessary. That is absolutely wrong. A flexible coupling will allow a machine to run when the 2 shafts are considerably out of line, but to obtain a smooth running outfit it should always be assumed that the coupling is solid and the shafts lined up accordingly.

In lining up from the coupling, conditions sometimes present themselves which, on first observation, seem nothing short of being paradoxical. Such conditions arise, for instance, from the couplings not being true on the shaft to begin with. Referring to Fig. 10,

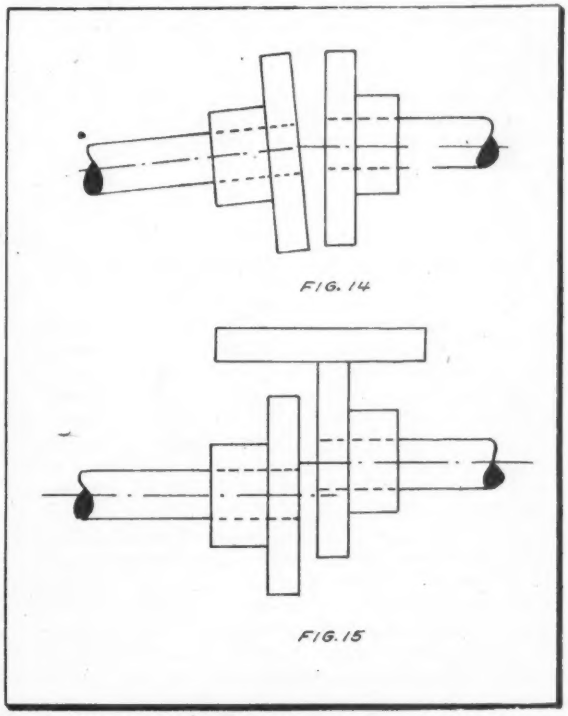


FIG. 14. POSITION OF SHAFTS WHEN TRUE COUPLINGS ARE OUT OF LINE

FIG. 15. SHAFTS PARALLEL BUT CENTER LINES NOT TOGETHER

here we have 2 shafts absolutely in line with the couplings off. Proceeding as before, when the shafts have been turned 180 deg., we get a condition shown in Fig. 11. It is natural to assume, first of all, that the coupling is true; then, in setting the machine from the coupling, faces as in Fig. 12, and rotating the shafts again 180 deg., we get a condition shown in Fig. 13, which is twice as bad as in Figs. 10 and 11. It will be at once apparent, therefore, that the coupling faces are not true, and this should be rectified, if possible, before final alignment is attempted.

In cases where it is impossible to true up the couplings satisfactorily, alignment can, with extreme care, be accomplished by working with taper gage in conjunction with straightedge in the same manner as explained above in connection with claw couplings.

With 2 shafts out of line and the couplings true on their shafts, as shown in Fig. 14, it will at once be apparent that by bringing the coupling faces into line the 2 shafts will, themselves, be in direct alignment.

If the machine is out of line, as shown in Fig. 15, a straightedge across the face of the coupling will indicate this. It will sometimes happen that these 2 coupling faces are not exactly the same diameter, but by taking measurements at 4 points and measuring the space between the straightedge and the lower coupling half by feeler gages, the amount of misalignment can at once be detected, irrespective of the different diameters of the coupling.

If the couplings on the shaft are not concentric, this can be easily detected by taking measurements by a straightedge, as shown in Fig. 15, keeping one shaft stationary and revolving the other.

TESTS FOR PACKING

Some Simple Rules to Aid the Engineer

By W. E. Sanders

THERE are few things to be purchased in the engineering line that are more perplexing to the buyer than packings. It is true that oils and boiler compounds are often perplexing, but an order for packing brings forth such a variety and so many conflicting claims that the conscientious purchaser is often weary of his task. The manufacturers of machines, or engines, or boilers are compelled by the importance of a single order to present facts that may be substantiated. But a single packing order is comparatively small and the skill or friendship of the salesman is often relied upon to secure the order.

As a help to the buyer of packing, I will give a few simple tests that may be applied, which, if they do not enable the engineer to choose the best, may aid in eliminating the poorer kinds more readily.

Flax Packings

MATERIALS used are a lubricant, which is about 30 to 45 per cent of the total weight, and either flax, hemp, or jute, or a mixture. The lubricant is usually about the same in quality. A test would have to be a chemical one and would not ordinarily be worth while. Pure flax is seldom used, since it would be too expensive. A mixture of flax and hemp is used in the better grades. It is almost impossible to tell these apart when once lubricated, and it is hardly necessary. Jute can be detected by boiling out the lubricant thoroughly, when the flax or hemp will appear like washed out cotton strings. The jute will be a distinct brown and of a finer texture. Jute is, however, more brittle under water than flax or hemp, and jute packing will not last so long.

Braided flax may be made up with all the strands braided in, or about a core, or about a core and with corners. Neither core or corners are visible except in a section cut square across. Cheaper material will be found in the core and corners first of all.

The cost of the crude material depends somewhat on the length of fibre. If the lubricant be thoroughly boiled out, and the packing dried, the length of fibres may be found by carefully unbraiding and combing out with a comb, taking care not to break off the fibres by rough usage. Water proof hydraulic flax is a braided flax that has been compressed and covered with graphite.

Gum Core Packings

GUM core packings are made of an outer lubricant usually white; an outer braided sheath impregnated with lubricant and made of flax and hemp mixed; an inner lubricant, between sheaths, of graphite; inner sheaths impregnated with lubricant and made usually of coarser fibre and of cheaper material than that of the outer sheath; and finally an interior core of rubber, either round or rectangular in cross section, as the packing may be round or oval in form.

The quality of the impregnated lubricant and the flax, hemp, or jute, is the same as used in braided flax packing. The outer lubricant is a mixture which varies in composition but which aims to produce a lubricant that will be white, or nearly so, and give a clean appearance, but not to be so soft as to melt easily nor hard enough to crack when bent sharply. The mixture is generally tallow or suet with the proper amount of paraffin or soapstone, or their equivalents.

The inner core is made of rubber and generally a very cheap rubber. It may be tested by slitting it down for an inch or two and stretching one loose end. The grade will be shown by the elasticity and the nearness of its return after stretching to its original length, as shown by the unpulled strip. A high quality of rubber is not needed, however. The claim is made that the rubber acts as a cushion to make the packing resilient. As a matter of fact, however, the rubber serves as a core about which to braid the sheaths during manufacture. Its value as a cushion may be shown by indenting it with a blunt pencil point If the indentation quickly disappears, it shows resiliency. For rubber used as a cushion this is a good test.

Hydraulic Packings

THESE are generally square in cross section and are not lubricated. They are made up of layers of duck or sheeting laid upon each other on the bias. The outer layers may be laid straight for appearance sake. The layers are held together by a "friction," which is a factory name for a rubber compound. The quality of duck or sheeting can not well be tested. The grade of coarseness or fineness may be seen by the eye. Fine hydraulic is made of sheeting or very light duck. Coarse hydraulic is made of a medium weight of duck. The fine hydraulic is used for hot or cold water. The coarse is used for cold water only. The friction of the fine hydraulic is usually white. Black is used on the coarse hydraulic. The friction should first be tested for the "cure" of vulcanization. If a single strip that has been peeled back, be pressed tightly on again with the thumb and sticks or is itself sticky, the friction is undercured and will not give good service. If the friction is dry or crumbly, the packing is either old or overcured. Overcuring is also shown by a brownness of the duck which is in reality a scorching of the duck.

Frictions differ in quality as shown by their strength. Peel a single strip back for an inch or two

and then peel it off at right angles. The more force needed to pull it off, the better friction and packing. The little threads of rubber that are stretched as the strip is pulled off also show the quality of the friction. But if the packing is undercured, long threads will show. This is detected easily by holding the strip close to the ear while pulling apart. If the friction is good and properly cured, a distinct crackling will be heard as the threads of rubber are broken after being stretched and fly back into place.

One difficulty experienced when these packings are put into service is the sometimes unnecessary amount that they will swell. As a rule, the finer the texture of the fabric, the less the amount of swelling. A comparative test is to measure 2 pieces very carefully, and then place in water for 10 or 12 hr. It will be found that the packing with the coarser threads in its fabric will have swollen the more. The lightest weight of fabric and strongest friction will give longest service.

Heat Expanding Packings

BY this class of packings I mean those composed of rubber and duck in construction like the hydraulic packings with the addition of rubber covers laid on the outside, and one kind with a rubber cushion or back vulcanized to one of the cut edges and generally protected from the wall of the stuffing box by a finely woven duck cover on its back.

The friction and the duck of these packings are tested, as are those of hydraulic packings. The rubber should be of a much better quality, however. The stretching test mentioned under gum core packings is good. The better form of these packings has the rubber back or cushion. This cushion does not need tensile strength, although that should be good. It should be of a fine and firm texture and be quite resilient, as shown by the blunt pencil test.

The lubricant should be examined carefully. In order that the lubricant may not dry out soon, it is customary for some manufacturers to use oil to hold the graphite. This is bad. The oil rots the rubber. A dryer lubricant may fall off if the packing is unused for a long time but the rubber will still be good. On the other hand, an oily lubricant may ruin the rubber inside of a few months. The friction should not be too thick. If it is, a soft and mushy packing is produced and it will not last as long.

Some buyers ask about the use of shoddy or reclaimed rubber. Its presence cannot be detected by the layman without having a chemical analysis made. This is expensive and useless. It makes no difference whether reclaimed rubber is used or not in the compound so long as the compound, when used, responds to the tests given above. Very few, if any, of the frictions used in packings are free from reclaimed rubber.

Diagonal Packings

QUALITY of materials are to be tested as in the other packings. There is one point of construction that is especially important and that is that the wedges must slide very freely on each other. This point can be clearly seen by compressing the packing between the thumb and forefinger. When taken apart, flake graphite should be seen on the sliding surface. The flakes slide easily on each other and aid in making a plane surface of the rough edges of the duck. Amorphous or powdered graphite will not do, and the flake graphite should be in profuse abundance.

Asbestos Packings

TESTS for the friction between layers are the same as in the duck packings. The asbestos itself may be tested by very carefully separating a thread or strand and burning it with a match. If much burns off, it shows the presence of too much cotton. If it becomes very weak in tensile strength, it indicates short fibres. After having burned, the fibres may be separated and their actual length seen. The best asbestos fabric should have not over 10 per cent of cotton and should be long in fibre. The amount of lubricant used on a valve stem packing may also be estimated in a rough way by the burning test.

Sheet Packing

CLOTH insertion packings usually have a low grade of rubber. Not too much should be expected of them. They are often undercured to prevent rapid drying out. This can easily be detected by peeling off the cloth and testing the rubber for the sticky indication of the undercure.

Pure sheet packing, that is without any insertion of cloth, may be subjected to a number of tests. When bent sharply upon itself an overcure or age will be shown by the appearance of cracks. Sometimes it even breaks. Such packing is weak and useless. If, when bent, the packing does not rebound in a reasonably short time, or at once, it is a sign of an undercure. If the packing, when sharply bent or folded back on itself, shows no cracks and resumes its original form quickly, it has been properly cured. One exception is to be made. Plumbago packings are sold either undercured or uncured and are intended to be so used. Such a packing hardens quickly in use and will vulcanize itself to a clean flange. For rigid joints it is good.

The density of a rubber sheet packing may be tested by the close observation of a fresh cut edge and by indenting with the thumb nail. Many test it by biting on it. The denser packings are the better.

A good sheet packing should have a high tensile strength and little stretch. In this latter respect it differs from pure rubber. Pure gum has a considerable stretch and great elasticity. The best sheet packings are resilient but have little stretch and great tensile strength.

Sheet packings that are to be subjected to ammonia, or oil, or acids, etc., may be tested by boiling in oil or acid, or by letting stand in ammonia. For ammonia, the strongest ammonia should be used, and if possible, anhydrous ammonia gas. Boiling in oil or acid is a severe test, as the heat aids the disintegrating action. It is not practicable to boil in ammonia since the heat drives off the ammonia, which is gaseous.

Asbestos and fibrous sheets may be tested for tensile strength and by the burning test used on rod packings for cotton fibre.

The tests given in this article are intended to be simple tests that any buyer can apply and which will give approximately correct information. There are more careful laboratory tests but they are ordinarily not convenient.

These tests will serve to eliminate the poorer packings and to the rest may then be applied the best test of all, that of service, without much possibility of delay or loss due to the failure of a poor packing.

EVERY MAN that is working is working for himself, even though he may be employed by somebody else.—The Triumph Chronicle.

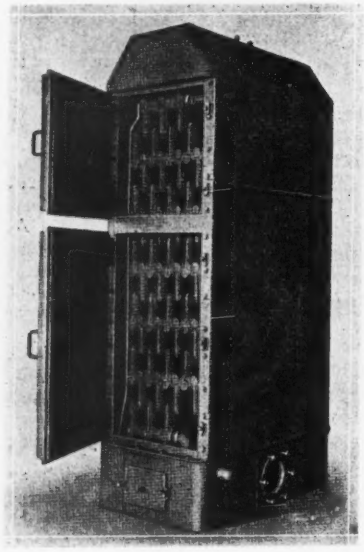
EUROPEAN POWER PLANT PRACTICE

Diesel Engine Waste Heat Economizer

By Francis G. Wickware

DETAILED results are given in a recent issue of the Zeitschrift des Vereins Deutscher Ingenieure of a series of tests on a commercial installation of the Sulzer apparatus for utilizing the waste heat of Diesel engines described in Practical Engineer for June 15. The motor in connection with which the apparatus was installed is in a Swiss woolen mill, working in parallel with a 400-hp. water turbine. It is a 3-cylinder machine, with 3 cranks at 120 deg. to one another, and works on a 4-stroke cycle at a normal speed of 160 r.p.m. During the summer and winter, the motor operates at full load or with some overload, during the remainder of the year at about ¾ load. With an average oil consumption of 3 grains per horsepower hour, the mechanical efficiency of the motor is 82 per cent at 25 per cent overload, 78 per cent at normal load, and 73 per cent at ¾ load.

The factory requires about 9700 gal. of water at about 158 deg. F. per day of 10 hr. To supply this



SULZER WASTE HEAT UTILIZER

2 Sulzer economizers, of the type shown in the accompanying illustration, were installed in series. Each has 325 sq. ft. of heating surface. To them is led the exhaust of the engine and the jacket water at a temperature of about 122 deg. F. A large part of the water used in the factory is cooled and filtered and reused in the jackets.

Tests were made under ordinary running conditions. The engine cylinders had not been cleaned for over a year. The exhaust gases at a temperature, according to the load, of 392 to 1022 deg. F., were led down through economizer I and up through economizer II, leaving the latter at a temperature of 185 to 310 deg. F. The flow of water was in the opposite direction to the flow of gases.

Briefly to summarize the results of the tests, the motor converts into useful work at half load, 26.6 per cent, at full load, 33.5 per cent, and at 25 per cent overload, 33.2 per cent of the heat contained in the fuel. The jacket water carries away, at half load, 34.4 per cent, at full load 27.4 per cent, and at 25 per cent overload, 26.7 per cent. From the exhaust gases the economizers recovered, at half load, 21.0 per cent, at full load 21.1 per cent, and at 25 per cent overload 21.2 per cent of the heat of the fuel. The total thermal efficiency of the plant is, therefore, 82 per cent.

Economizer II, of course, did not have the same efficiency as economizer I; still it recovered 100,000 B.t.u. per hour besides serving as a reserve. The total back pressure on the motor caused by economizers and exhaust pipe was about 1/5 atmosphere.

The tests prove conclusively that where hot water is needed for heating or other purposes, the waste gases of a Diesel engine may be used economically. From a 250-hp. plant may be recovered 3700 B.t.u. per horsepower hour, or 2800 million B.t.u. in a year of 300 10-hr. days. At the prevailing Swiss prices for coal, this means a saving of little less than $1000 per year. The interest, depreciation and attendance charges for the economizers will certainly be no greater than for any other type of heating plant.

ROPE DRIVING

IN a paper read by R. E. Hart before the Association of Engineers-in-Charge (England), the author stated in a concise manner the main requirements for a successful rope-drive. The main features of an ideal rope-drive are that the diameter of the pulleys shall not be less than 30 times the diameter of the rope used, and the driving and driven pulleys shall, if possible, be of equal diameter; but where this cannot be arranged, their ratios should not be greater than 5 to 1. The distance between the pulley faces should if possible, be not less than 25 ft., and the drive should be horizontal, with the slack side of the rope on the top. The speed may be from 2000 ft. to 4000 ft. per minute. If the speed is too low the ropes are apt to slip, and if too high the action of centrifugal force affects the efficiency.

There should be a distance of from 4 ft. to 6 ft. clearance under the ropes, and the ropes must, of course, not rub on anything. An allowance of 2 or 3 in. clearance between the bearing foundations and the sides of the pulleys must be made so as to leave room for the ropes to be put onto the pulley. The pulleys must also be accurately in line, well ballanced, and the grooves exactly alike. All gears between the prime mover and the rope-drive should, if possible, be avoided; the ropes should be kept dry, properly lubricated, and not too tight. They should all be put on at one time, and the full load should be applied to them as soon as possible after they are in place. Carrier pulleys, rollers, and angular drives should be avoided as much as possible.

Regarding the 2 types of rope generally used—namely, 3-strand and 4-strand—the former can be made more pliable than the latter, and it is also stronger; but these advantages are more than counterbalanced in the 4-strand rope, because, compared with the 3-strand, it stretches very much less, and it has a larger surface in contact with the pulley grooves; it is also capable of a stronger splice. A well-made 4-strand rope is, moreover, nearly as strong as a 3-strand, but it requires more skill to splice it. The general opinion now is that cotton is the best material to use for driving-ropes, and Egyptian cotton, though a little more expensive than American, is generally preferred.

A BLAKISH incrustation, in some places four inches thick, on the under side of the cornice of St. Paul's Cathedral, and due to the action of sulphric acid upon the stone, testifies to the effects of the smoke evil in London.

CORROSION FROM PURE WATER

Bad Effects in Boilers of Having Water Too Pure

By W. A. Converse*

IN ORDER THAT the reader may better grasp what the writer may have to say later, it seems advisable to consider first the substance water in a pure state. Pure water is composed of 2 gases; viz., hydrogen and oxygen, chemically combined in the proportion of 2 parts of hydrogen and one part of oxygen by volume, or 2 parts of hydrogen and 16 parts of oxygen by weight.

When pure, hydrogen is a colorless, odorless and tasteless gas, not at all inflammable, but a strong supporter of combustion.

Water is the greatest and most universal solvent known, and it is doubtful if there is known any substance or material which is not to a less or greater extent dissolved, disintegrated, or in some way changed by it in course of time. In referring to the purity of water in this particular case, we have only in mind its freedom from dissolved, solid, or mineral substances. To the layman, iron is insoluble; it is not soluble in water to the same extent as are sugar or salt, but a gradual solution is constantly going on, in the proportion of a minute quantity of iron to a large quantity of water.

If a water contains certain substances in solution, its solvent action is reduced in proportion to the amount of such substances contained.

In the past, many theories have been advanced as to the cause of corrosion of iron, among them being the theory of electrolytic or galvanic action, which is at the present time considered the most rational, and is therefore the one most generally accepted as correct. This theory is to the effect that under the conditions existing in the interior of steam boilers in service, at least a partial dissociation of the water itself takes place, resulting in the presence of hydrogen (H) and hydroxyl (HO) ions.† These ions being infinitely small particles, each electrically charged, the hydrogen ions being positively charged and the hydroxyl ions negatively charged; this dissociation results in an increased rate of solution of the iron.

In case of a pure iron in water, a perfectly analogous condition exists. The water being dissociated and in contact with the small bodies of pure iron in the sheet or tube, there go into solution in the water iron atoms in the form of positively charged ions. Hydrogen, which acts in this reaction as a metal, and which is here so considered, has a much smaller solution pressure than iron, hence, an equivalent number of hydrogen (H) ions separate out on the pure iron (leaving the free hydroxyl (HO) ions with their negative charges to balance the iron ions with their positive charges), and an electric current flows by means of the iron ions to the solution, and by means of the hydrogen from the solution back to the iron again, thus completing the circuit.

Now, if the iron constituting the tubes or sheets was absolutely homogenous, any corrosion would take place uniformly over the entire surface submerged in the water, but such is not the case. Iron and steel of all types and kinds contain impurities or substances other than pure iron, which exist in miscroscopic bodies, such as might be compared to a mixture of sand, sawdust and charcoal, each of these substances being so finely powdered as to make them invisible in the mixture without the aid of the microscope. Since the solvent action exerted by pure water is greater on some of the compounds or substances present in the iron, than upon others, the solvent action shows itself in the form of pitting.

In conclusion, the writer desires to say that to enter into a detailed discussion of the corrosion of steam boilers require the writing of several volumes of considerable size. He has endeavored, however,, to furnish a sufficient amount of information, and in such form as to prove a meager explanation of why pure water exerts a very corrosive action when used in steam boilers.

*Secretary and Chemical Director, Dearborn Drug & Chemical Works.

†For all intents and purposes at this time the reader will consider atoms and ions as infinitely small, uncombined particles of the substances referred to.

REMARKS BY AN OLD FOGY

THERE is a good deal of talk to-day about economy. There is also a great deal of room for the practice of economy. Naturally with this great amount of room and deal of talk much that is more or less foolish is said and advised. I read an article recently by an employe admonishing his fellows to be more economical in their use of the time and material of their employers. The plea was timely and proper, for neither the time nor the material of an employer should be wasted by his employe.

To strengthen his point the writer told this story about the late Collis P. Huntington: One day the railroad president happened into one of the company's offices in San Francisco. In drawing some small change from his pocket a dime fell, rolled a few feet and dropped through a crack in the floor.

Did Collis P. Huntington let that dime go as a matter too small for one in his position? No. He sent an office boy for a hatchet. He took the hatchet, got down on his knees on the dusty floor, pried up the board, breaking it to splinters in the operation, fished around till he found the dime and triumphantly held it up for the inspection of the gaping clerks.

After reading this, I fell into a train of speculation. Naturally I wanted to know how much economy really had been practised in the recovery of that dime. I figured it out in this way:

Cost of C. P. H.'s time	$3.50
Boy's time in getting hatchet	.03
Cleaning and pressing H.'s trousers	.50
New board for floor	.15
Carpenter's time replacing board	.30
Total cost	$4.48
Credit, by one dime	.10
Actual cost of recovery	$4.38

I concluded that if Mr. Huntington practiced this method rigidly the saving to himself and to his company would look a good deal more like a drummer's expense account than like a statement of profits.

If he wanted to recover the dime at the least cost he would have sent for the carpenter in the first place, instructed him to get it and then have gone about his own high-priced affairs. In such case the recovery of the dime would not have cost more than about one dollar and a half, or a saving of $2.88. Which still would leave it a somewhat expensive dime.—Valve World.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

CONCEALED WIRING

Practical Suggestions for the Installation of Knob and Tube Work in Frame Buildings

By Arthur O'Brien

CONCEALED knob and tube wiring, used in frame buildings, is commenced just after the floors and studding are in place and before the lathing is commenced. Running of the wires is called the "roughing in," and comprises the installation of the mains and the branches and the taps to the outlets. Frequently the basement wiring is not started until the building is practically completed.

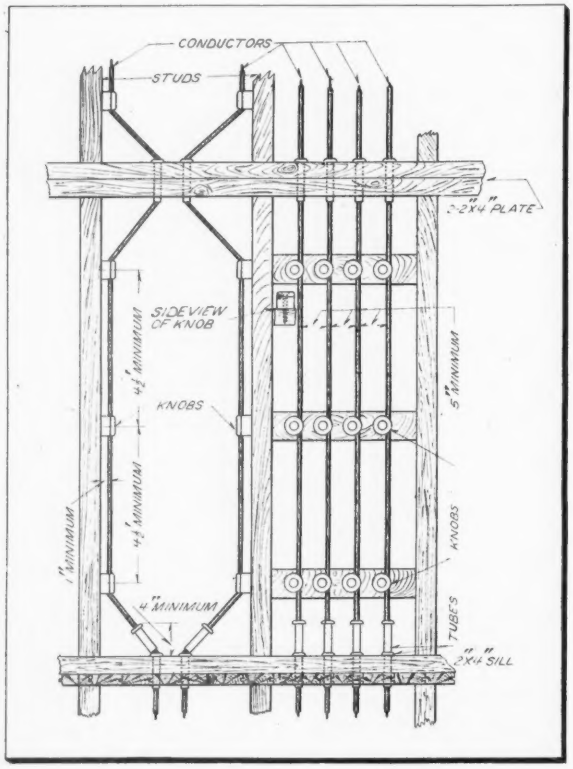


Fig. 1. KNOB AND TUBE VERTICAL RUN

Finishing, which comprises the installation of the switches, fixtures, meter board, distributing panels, etc., is not usually done until the building is otherwise completed.

Wire and tie wires for concealed knob and tube wiring must have an approved rubber insulation, but may have a single braid. Tie wires should have an insulation equal to that of the conductors they support, and must not be smaller than No. 14 B and S gage.

In making joints and splices, a serving of rubber tape and then one of friction tape are made around the splice. Inasmuch as most of the joints are inaccessible after the completion of the building, they should be carefully made.

Wires must be supported by approved porcelain knobs, which separate the wires at least 1 in. from the surface wired over, and must be maintained at least 5 in. apart and, when possible, should be run on separate timbers and studding, as shown in Fig. 1. Knobs are located at least every 4½ ft., where the wire run is parallel to the supporting timber. Where it is impossible to maintain the 5 in. separation, the wires can be run closer together, provided each is encased in a continuous length of flexible tubing. When passing through floors and walls, the wires must be protected by glass or porcelain tubes, as outlined in Fig. 1. Flexible tubing may, in dry places, be used to insulate the wires where projecting members of the building interfere with them. Porcelain tubes should be used where the wires cross each other or cross pipes, as shown in Fig. 2.

Where circuits cannot be supported on porcelain or glass, approved metal conduit or armored cable must be used, except that for voltages of less than 300, where the wires are not exposed to moisture, they may be fished from outlet to outlet on the loop system, if each is encased throughout in a continuous length of approved flexible tubing.

When wiring in thin partitions, where there will not be at least 1 in. clear space between the wires and the plaster that oozes between the laths, the wires must be encased in flexible conduit. This construction is required in the so-called 2-in. partitions.

Knobs may be either of the solid type or of the split type. Split knobs are required for conductors smaller than No. 8, except at the ends of runs. The knob must provide at least a 1-in. separation from the surface wired over. The solid knob is the cheapest, but the additional cost of the tie wire required and the labor of tying makes the cost, installed, about equal to that of the split knob. The split or confining knob is unquestionably superior to the solid knob, as no tie wires are required when it is used. In some localities inspectors require that a tie wire be used even with the split knob, because Code rules specify tie wires. The rule is not always strictly enforced.

Breaking of knobs at the time of putting them up with screws is not the only source of trouble, for the binding tension applied often acts to crack the knob a considerable time after it has been put in place. It is an objectionable practice of many wiremen in putting up knobs with screws to drive the screws in

nearly all the way, giving them only a couple of turns with a screwdriver to tighten them.

Porcelain Tubes

PORCELAIN tubes can be obtained in many lengths and sizes. The tube through any one hole must be continuous. A tube 3½ in. long, ⅝ external diameter and 5/16 in. internal diameter, is the size most frequently used in ordinary house wiring.

Porcelain tubes provide insulation where the wires are carried through joists, as shown in Fig. 3. The holes for the tubes should preferably be slightly smaller than the tubes, so that when driven home with a

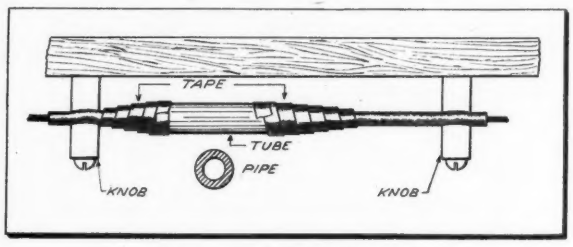


FIG. 2. WIRE CROSSING PIPE

block of wood the tube will stay in place. The holes for tubes for small wires should be pitched, as this tends to retain the tubes in position in the timber.

A long bit, the shank of which, when in use, rests on the joist next to the one being bored, is the tool for boring pitched tube holes. Tubes should always be so placed in pitched holes that their enlarged ends will be at the top, to prevent their falling through.

For heavy conductors the tube holes should be bored with a beam boring machines, at right angles to the beam. If they are not, it is difficult to pull in the wire and tube breakages will result. Abut 10 per cent more wire is required where conductors are "zig-zagged" through timbers, than when they are carried straight through.

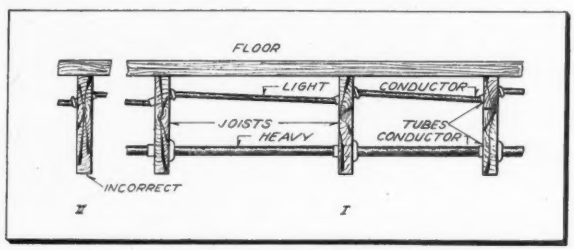


FIG. 3. WIRES THROUGH JOISTS IN TUBES

Porcelain tubes must be used on wires at the bottoms of plastered partitions, an additional tube being placed where the wires pass through the sill or floor, to protect them from plaster droppings. The tube must extend to at least 4 in. above the timber. Knobs must be so arranged that no strain that might tend to break them can come on tubes.

Flexible tubing must be used at all outlets to encase each wire. It should be used at distributing centers, switch, fixture and similar outlets, and at all points where the wires cannot be separated the distances specified for unprotected wire. The flexible tubing must encase each wire from the last porcelain support to 1 in. below the outlet, or with combination fixtures, to a point opposite the gas cap.

(To be continued.)

PRACTICAL ELECTRICAL ENGINEERING

Magnetism and Its Discovery; Permanent Magnets, Magnetic Circuits and Lines of Force

MANY centuries ago, in the town of Magnesia in Asia Minor, the natives discovered an ore which to them had the astonishing property of attractihg pieces of iron. This property they named magnetism, and the piece of ore a magnet.

On analysis this ore was found to be composed of 72 per cent iron and 28 per cent oxygen, and has since been given the name magnetite. It was discovered that when a piece of magnetite was suspended by a string, one end invariably pointed northward. After this discovery it became apparent that ships could be guided by it and it was therefore extensively used in navigation and was given the name of lodestone, meaning leading stone, and from this primitive beginning our present-day compass was evolved.

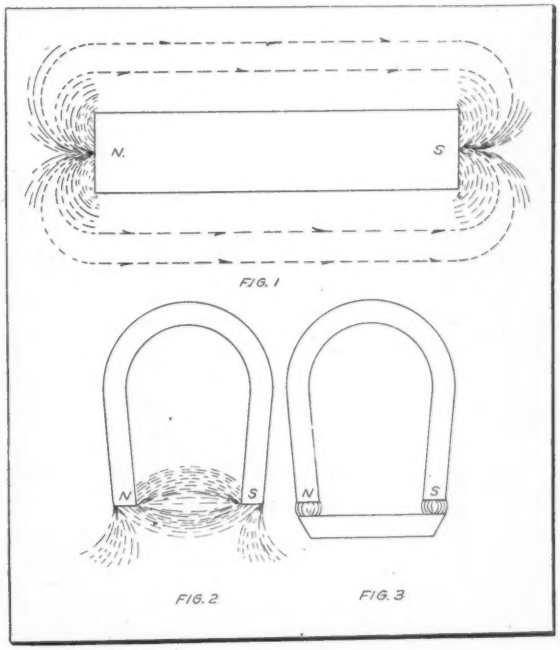


FIG. 1. BAR MAGNET SHOWING PATH OF THE LINES OF FORCE
FIG. 2. HORSESHOE MAGNET
FIG. 3. HORSESHOE MAGNET WITH KEEPER

The earth has 2 magnetic poles whose axis conforms nearly with that of the geographical poles. The end of the compass needle that points north is termed the north-seeking pole and is in reality a south magnetic pole, as like poles repel and unlike poles attract each other, as will be explained later.

Further investigation led to the discovery that if a piece of hardened steel be rubbed with a lodestone it became highly magnetised, and when one end was plunged into a dish of iron filings a considerable quantity would adhere to it. It was likewise found that this was true of the other end, no filings, however, adhering to the center of the piece of steel. From this phenomenon it was deduced that when magnetised, the steel bar possessed 2 poles, and it was therefore assumed that there must be a magnetic circuit consisting of the steel bar and the medium with which it was surrounded, and this has proved to be true.

This property of magnetism can be illustrated by placing a bar magnet on a table and covering it with a piece of paper over which iron filings are sprinkled. Upon tapping the paper gently the filings will assume definite lines, some of which are dissipated in the air and others extended from one pole to the other, as shown in Fig. 1. These magnetic lines are known as lines of force and with the exception of leakage, form a complete magnetic circuit, either through the air or through other magnetic substances.

From the fact that bar magnets can utilize only a portion of the effective lines of force, they are usually bent into the form of a horseshoe and are known as horseshoe magnets, as shown in Fig. 2. This shape brings the poles nearer together so that when placed against a magnetic substance the magnetic leakage is reduced to a minimum. The path of the lines of force surrounding the 2 poles can be shown by repeating the experiment with the paper and iron filings.

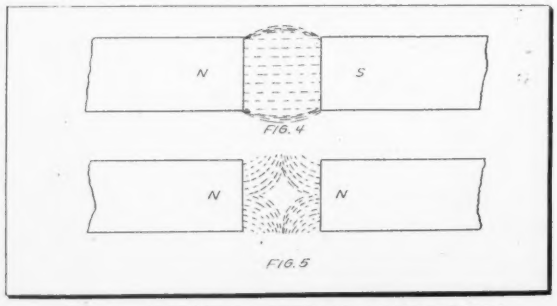


FIG. 4. ATTRACTION BETWEEN UNLIKE POLES
FIG. 5. REPULSION OF LIKE POLES

To prevent a horseshoe magnet from losing strength when not in use, it is customary to place a small bar of soft iron, known as a keeper, across its poles. Fig. 3 illustrates the keeper slightly removed from the poles to show how it concentrates the lines of force.

Two similar poles repel and 2 dissimilar attract each other, as stated before. These phenomena can be illustrated by means of the paper and iron filings, as shown in Figs. 4 and 5. Soft iron or steel will readily magnetize, but when removed from the magnetizing source will rapidly lose strength, retaining only a small percentage of its original strength, that which remains being termed residual magnetism.

Magnets made from hardened steel, owing to their ability to retain the magnetism, are known as permanent magnets. There are other elements that can be magnetized to a lesser degree and include nickel, cobalt, manganese, cerium and chromium. Iron and its aloys, however, are used for magnets entirely.

THERE ARE 759 gas engine manufacturers in the United States, not including builders of automobiles. It is estimated that they made nearly half a million gas engines last year whose total horse power exceeded 3 million.

Not counting automobiles, it is a question if the total gas engine horse power in the United States does not exceed the total steam horsepower in manufacturing plants. In 5 yr., yes in 3, the gas engine will be far in advance of the steam engine so far as total power is concerned, and yet we are only at the beginning of the gas engine age. The farms of the United States alone should have at least 30,000,000 hp. to help do the chores around the farm house and barn.—Gas Review.

PORTABLE SUBSTATION

Some Novel Features Including an Out Door Transformer Mounted on the Car and Leveling Device for Rotary Converter

PORTABLE substation of a new and unusual design has been placed in service on the lines of the Scranton & Binghampton Traction Company. The novel features are the use of outdoor type transformers; the application of Burke horn-type switches, and the general arrangement of the lightning

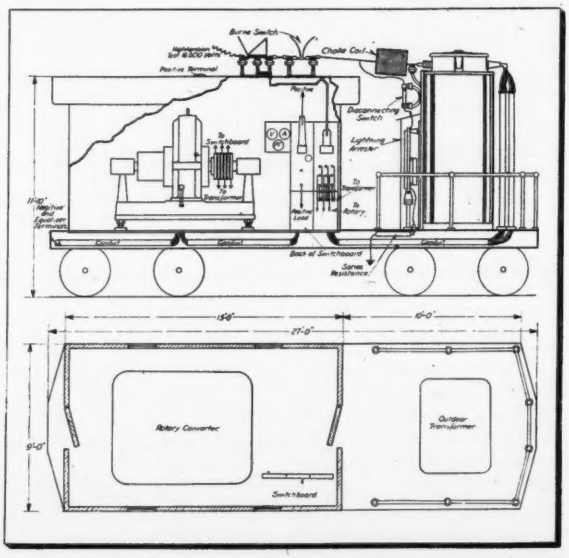


FIG. 2. SECTIONAL ELEVATION AND PLAIN VIEW OF OUTDOOR TRANSFORMER SUBSTATION

protective apparatus. Because of these features, the car is much shorter and lighter than the usual substation car; its length being but 27 ft.

Another innovation in design is the leveling device for the converter, which provides a means for leveling the machine, even when the car is standing on a decided grade. The low tension cables between trans-

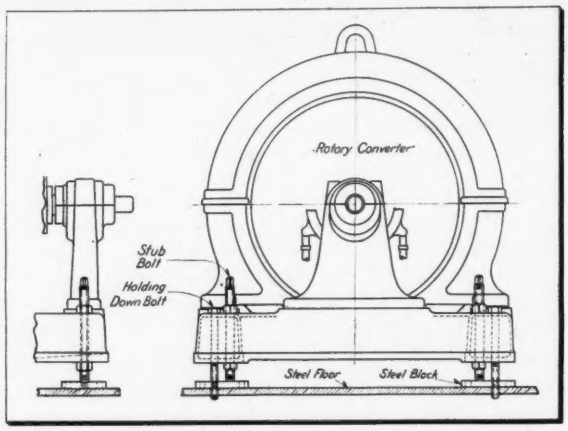


FIG. 3. LEVELING DEVICE FOR ROTARY CONVERTER

formers, switchboard and converter are carried under the car in conduit, which differs from the usual method of running these conductors on substation cars. The general arrangement has been planned so that all of

the apparatus will occupy minimum space, but still so that it will be convenient of access and have ample working room around it.

The 440 kilowatt, 3-phase, oil-insulated, self-cooling, outdoor type transformer, is wound for 16,500 volts primary, and is secured to the floor with foundation bolts which pass down between 2 specially arranged 6-in. channels and which are held to the bottom of these channels with washer-plates.

High tension conductors from the line are brought down to the roof of the car and connected to the Burke horn-type switches from which they pass through the horn-type fuse and the choke coil and into the primary side of the transformer. On the low tension side of the transformer, the cables drop in conduit directly down through the floor and run through conduit which is supported from the side structure.

ahead of the suspension choke coil, and the circuit passes down through disconnecting switches to the arrester. From the arrester, a lead in which is inserted a series resistor extends to ground.

A 400,000 circular mil cable, specially insulated with 7/64 in. varnished cambric and with weatherproof braid, extends from the secondary windings of the transformer to the converter. The cable is carried in wrought iron conduit under the car. The function of the conduit is not so much to protect the cable as to provide a convenient means for supporting it.

The rotary converter is a 400-kw., 600-volt, 25-cycle, 6-phase, 750-r.p.m. machine, and is equipped with an oscillator and an overspeed limit device.

Two 2-in. black slate panels, mounted on an angle iron structure bolted to the floor and braced to the side wall of the car, with a wing for the instruments,

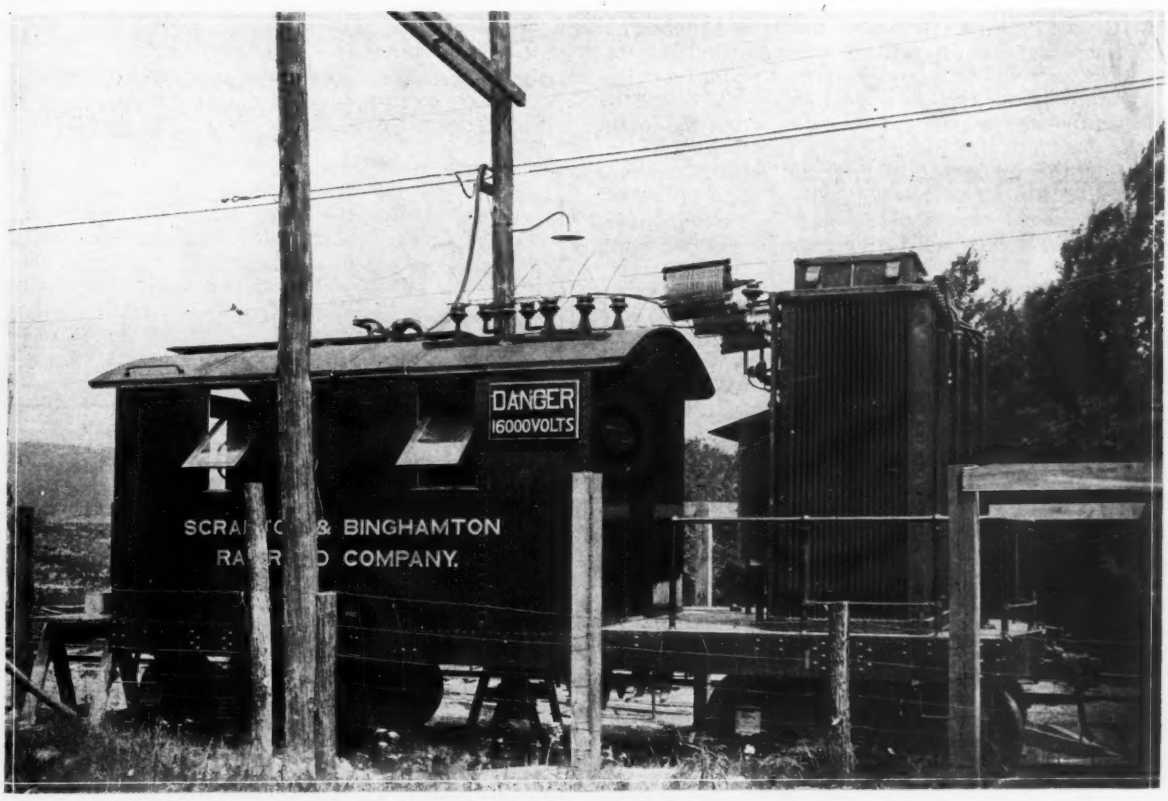


FIG. 1. OUTDOOR TRANSFORMER SUBSTATION IN SERVICE

A 16,500 volt, 100 ampere, Burke high voltage air break switch constitutes the high tension. The 3 movable horns of this switch; one in each phase, are connected by bell cranks, and may be actuated by a standard oil switch which is arranged for automatic operation and is mounted on the switchboard. The horn switches, however, sever the high tension circuit automatically in case of overload. From the switch, the circuit passes through Burke horn-type fuses, which provide further automatic protection of the high tension side of the transformer. The Burke switch is the only switching device in the primary circuit.

Westinghouse low-equivalent arrester provides lightning protection. The arrester is supported between the transformer and the superstructure on a steel framework bolted to the transformer. An ebony asbostos wood casing completely encloses the arrester. The arrester is tapped to the high tension circuit just

constitute the switchboard. The alternating current panel carries the switch handle operating the high tension switch, which is arranged to provide automatic overload protection, and a triple-pole, double-throw, knife switch for starting and running converter. The direct current panel carries a type C carbon circuit breaker, a rheostat handle, a single-pole knife switch, and a voltmeter receptacle plug. All of the instruments: a direct current voltmeter, a direct current ammeter and a powerfactor meter, are caried on the wing.

Two 400,000 circular mil cables for each negative, and one equalizing lead, run from the left-hand side of the rotary converter, through the floor and through conduit to the end of the car where each pair is soldered into a terminal to which connections can be bolted. The positive lead, which also consists of 2 400,000-c.m. cables, runs from the right-hand side of

the converter, below the floor, and up back of the switchboard, through the knife switch and circuit breaker to the roof of the car where it is brought out through a conduit fitting. This lead also ends in a terminal to which a connection to the line can be bolted.

All of the apparatus in the sub-station is of Westinghouse manufacture with the exception of the horn switches and fuses, which were manufactured by the Railway & Industrial Engineering Company, which concern designed and equipped the car.

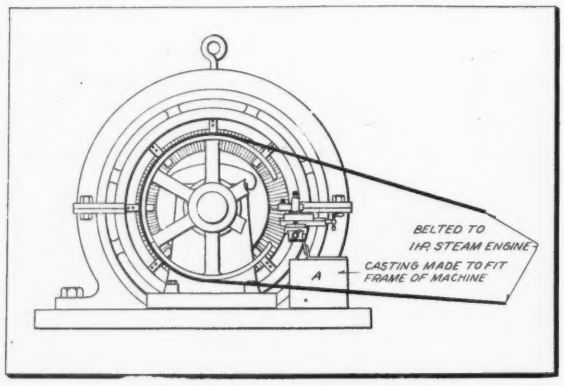
COMMUTATOR TURNING DEVICE

Simple Arrangement for Turning Commutators Without Removing the Armature

By J. B. Linker

ACCOMPANYING sketch shows a satisfactory arrangement for turning commutators and collector rings of rotary convertors: The commutator lathe heretofore used had been bolted to 2 4 by 4 in. oak timbers that extended across the frame of the machine; this did not work satisfactory on account of the timbers springing and letting the tool "hog" into the commutator.

To overcome this trouble I had the casting made, shown at A, to bolt fast to the machine and the lathe



COMMUTATOR TURNING DEVICE

was then fastened to the casting. This not only overcome the spring, but saved the trouble of lining the lathe up every time the commutator was turned. The lathe was lined up and holes drilled in all of the machines so as to be interchangeable. The pully which is 3 ft. in diameter fastens to the end of the shaft. The armature had previously been turned by hand, and is quite a job for the man that has the turning to do.

I had a one hp. steam engine available and belted it to the armature and run it with compressed air, this cut out the labor of turning the armature and gave a steady speed. By this arrangement we are able to do a much better job, and it only requires one-half the time.

Electrolyte, the solution used in primary and secondary batteries is defined as a decomposable liquid, or one that may be decomposed by means of an electrical current. Acid electrolyte is largely used for lead plate storage batteries, while an alkaline electrolyte composed of dilute caustic soda or potash, is used for the Edison type primary and secondary batteries.

PRACTICAL MATHEMATICS

Problems in Cancellation Showing How This Method Shortens the Process of Continued Multiplication and Division.

IF a man exchanged a carload of iron castings, containing 40 short tons of 2000 lb. each, and valued at 5 cents a pound, for 4000 sacks of cement, each containing 200 lb., what is the cost of the cement a pound?

By simple arithmetic, this example would be expressed as follows: $40 \times 2000 \times 0.05 = \$4000.00$; $4000 \times 200 = 800{,}000$. $4000.00 \div 800{,}000 = \$0.005$.

The value of the cement is therefore ½ cent a pound.

Where continued multiplication and division are involved, as in this problem, the operations are greatly

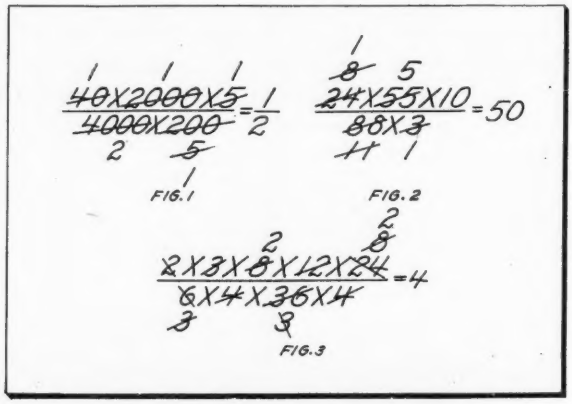


FIG. 1. CANCELLATION OF FIRST PROBLEM
FIG. 2. CANCELLATION OF SECOND PROBLEM
FIG. 3. SIMPLIFIED WORK OF EXAMPLE IN CANCELLATION

simplified by cancellation. This eliminates the necessity of multiplying together all of the numbers in the dividend and dividing the product by the product of the numbers in the divisor.

In order to cancel, express the entire series of operations as in Fig. 1; take any 2 numbers, one above and one below the line and divide them by some number that is contained in both without a remainder.

In the given example, we find that 2000 divides into 2000 above the line and 4000 below the line, leaving as a result 1 over the 2000 and 2 under the 4000; see Fig. 1. Then, 40 will divide into 40 above the line and 200 below the line, leaving a result, 1 over 40 and 5 under 200; 5 above and below the line cancel. We now multiply the remaining figures above the line for a new dividend, and those below the line for a new divisor, giving ½ cent as before.

An engineer sold 24 boxes of scrap copper, each containing 55 lb., at 10 cents a pound, and received as pay, 88 cans of oil, each containing 3 gallons. What was the cost of the oil? The operation is shown in Fig. 2. Below the line, 3 divides 3, and above the line 24, leaving as a result 1 and 8 respectively; 8 and 88 are then divided by 8, leaving 1 and 11, and 11 and 55 are divided by 11, leaving 1 and 5 respectively. The product of the numbers not cancelled, 5 and 10 equals 50; the value of the oil per gallon, therefore, is 50 cents.

The number of factors above and below the line is not limited and can be extended as far as space on the paper permits. As an abstract example, divide $2 \times 3 \times 8 \times 12 \times 24$ by $6 \times 4 \times 36 \times 4$. The operation is shown in Fig. 3.

In practice it is not necessary to set down the figure 1 in any cancellation operation, as it does not change the values of results in multiplication or division operations. Furthermore, we do not stop to think what number wil divide 2 numbers, one above and one below the line, but select any number above or below that will exactly divide a number on the opposite side of the line and cancel. For example, if 2 is above the line and 6 below, we say 2 is contained in 6, 3 times; cancel 2 and 6 and set down 3 under 6. We have, nevertheless, performed the operation of dividing 2 and 6 by 2. Likewise, cancel 3 above with 3 below the line; 4 below the line into 8 above, leaving 2; 12 above the line into 36 below, leaving 3; 3 below the line into 24 above, leaving 8; 4 below the line into 8 above, leaving 2. This leaves 2×2 above the line, giving an answer 4.

SUBSTITUTING

George's Experiences in a Strange Plant With Special Equipment

THE other day my wife was sick and being an off day it was up to me to stay home and be nurse. I was a cross nurse, but not a Red Cross one. After I had fed the children and sent them to school, washed the dishes, baked the bread, made the beds, darned some stockings, manually and verbally, and 57 varieties of other things, she called me to her and asked me if I thought that I could do the family wash in a pinch.

Well, I have washed boilers for many years, and I thought that I would not be downed by a washboiler, so I said that I could get away with it. I went down to the laundry and proceeded to get up steam. I filled the washboiler up to the 3rd gage and fired up. The draft wasn't as brisk as it is over at the works, for I had only about a 64th by the gage, and sometimes this was a minus quantity and made a down draft of it, for the smoke came out through the grates something scandalous.

In due time, however, I got things hot and then my troubles began to multiply rapidly. I poured the boiling water into the washer and the imp of gloom immediately got on the job, for I had forgotten to close the blowoff valve and before I got the plug in, I had lost so much water that the crownsheet was bare on the washboard.

This is not a license community, but I think that it would be advisable for an engineer to pass an examination of some sort so as to make it safe for himself before being compelled to do the weekly wash. Then this washing machine is a peculiar affair. I bought it for my wife because she said it was what she wanted, but if I had known that I would ever have to run it, I would have bought a simple, non-condensing type.

It is one of those hydro-electric vertical affairs, without the electric attachment, of the inverted type, like a Curtis turbine. So I put some clothes in the washer, clapped on the manhole cover, and turned on the juice. It went.

In about 15 minutes I shut down, as wife said, and proceeded to wring out the clothes. This was quite a task, for the first thing I did was to wring out a flimsy little rag that women call a doily; but the first thing I knew it began to wind arount the pulley. I tried to reverse the machine but that made matters worse for the other end got caught and there I was, for I couldn't go either way, and had to take the wringer apart to get the doily out.

By this time the water was cold and I had to get up steam again. This time things went better, only I got my thumb caught in the valve gear of the wringer and the nail was a beautiful color; but I found later that this was because I spilled the blueing powder and when the black and blue thumb nail was readily washed off, it stopped hurting.

Of course I didn't know how to sort out the clothes and really was not to blame because one of my purple sox got into the same batch with the napkins, pillow cases, etc., and made them look like a $10,000 illustration of the setting sun by Mike Angelo.

Then, some how or other, I pulled the wrong lever when it came to washing the woolens and when it was all over I couldn't find my underwear till at last I found several pieces that would fit the boy, Ivan, and some more that would about size up with a doll. Then I tumbled that the latter were the boy's and his was mine. If I am compelled to do the washing a few times more, all the woolens will shrink to about one garment and that of small size.

Of course every man is bound to make some kind of a bum steer the first time he tackles a new job, but it seems that I got more than my share. The starch bothered me some till I recalled the formula that is used in making paste for pipe covering and the result was all that one could wish for—that is, if I was that one.

I couldn't find anything in Hawkins' Mechanical Dictionary or in The Encyclopedia of Steam Engineering as to what to starch and what not to, but always having made it a practice to do too much rather than too little, I followed out this precept to my sorrow.

It isn't so bad to eat off a cotton imitation of a sheet of No. 20 gage galvanized iron, or wipe your face with a shingle in lieu of a towel. To slumber on a sheet that resembles a plate of half-inch steel, with your head on a pillow case that has the shape and density of a mud drum isn't bad either, and an engineer ought not to complain; nor yet should he if his overalls stand alone after the ablutionary process. But when a fellow finds it necessary to gain admittance to his undergarments which have already shrunk several sizes, and which make him think that he is putting on a length of stovepipe with a couple of lengths of downspout for sox, he thinks it is time that he was allowed to return to the engine room and let the kind-hearted neighbors do the washing in the future.

The next time I do the family washing, I won't do it.

P. S. By holding my overalls under the air cock of the feed pump for about half a minute, I found that they could be dented so that they could be entered without standing them upright in the pump pit and jumping down into them.

A SIMPLE WAY TO DETECT acid in lubricating oil is as follows: Place a little of the oil in a closed bottle, and add an equal amount of water in which has been dissolved a small amount of sodium carbonate. If the mixture be shaken violently and then set aside and allowed to settle, the amount of sediment will be an indication of the amount of acid in the oil. This does not, of course, tell the exact quantity of acid present, but is a useful comparison of the relative amounts of acid in several samples of oil.

DEARBORN METHODS

Processes Employed by the Dearborn Drug & Chemical Works for the Treatment of Feed Water and the Manufacture of Lubricating Oils; Bowser Self-Registering Pipe Line Measures and Pumping System a Feature of the Oil Department

TO the uninitiated, the laboratories of the Dearborn Drug & Chemical Works, of Chicago, would be a veritable mystery, equipped as they are, with beakers, retorts, test tubes, Bunsen burners and a multitude of scientific instruments for determining the treatment necessary for boiler feed waters, the properties of lubricating oils and the analysis of coal.

Samples of feed water, for analysis, in diversified containers reach the laboratories in large quantities each day. Lubricating oils manufactured by this company are tested in an oil laboratory for viscosity, flash point and specific gravity and electric ovens furnish the heat for the purpose of determining the chemical and physical properties of coal, besides many other devices necessary to make up the equipment of a scientific laboratory. A representative of Practical Engineer recently paid a visit to the laboratory and works of this company and was so impressed with the valuable work accomplished that a detailed description of the processes employed was thought to be of more than ordinary interest to the engineers.

It must be understood that the treatment of boiler feed water requires a thorough knowledge of the kinds and quantities of the different substances contained in the water used in the boiler, the condition under which it is used, the ability to select without question proper remedial agents for each substance contained in the water, and to choose agents which will not cause the formation of deleterious substances which might produce troubles different from those which previously have been common to the plant.

In order to deal intelligently with the subject of feed water treatment, a thorough knowledge of chemistry, both theoretical and applied and of steam engineering, both practical and theoretical must be at hand. Complete, suitable and properly equipped laboratories must be maintained and operated by a thorough and competent chemist, especially trained in water analysis, and of equal importance a suitably equipped man-

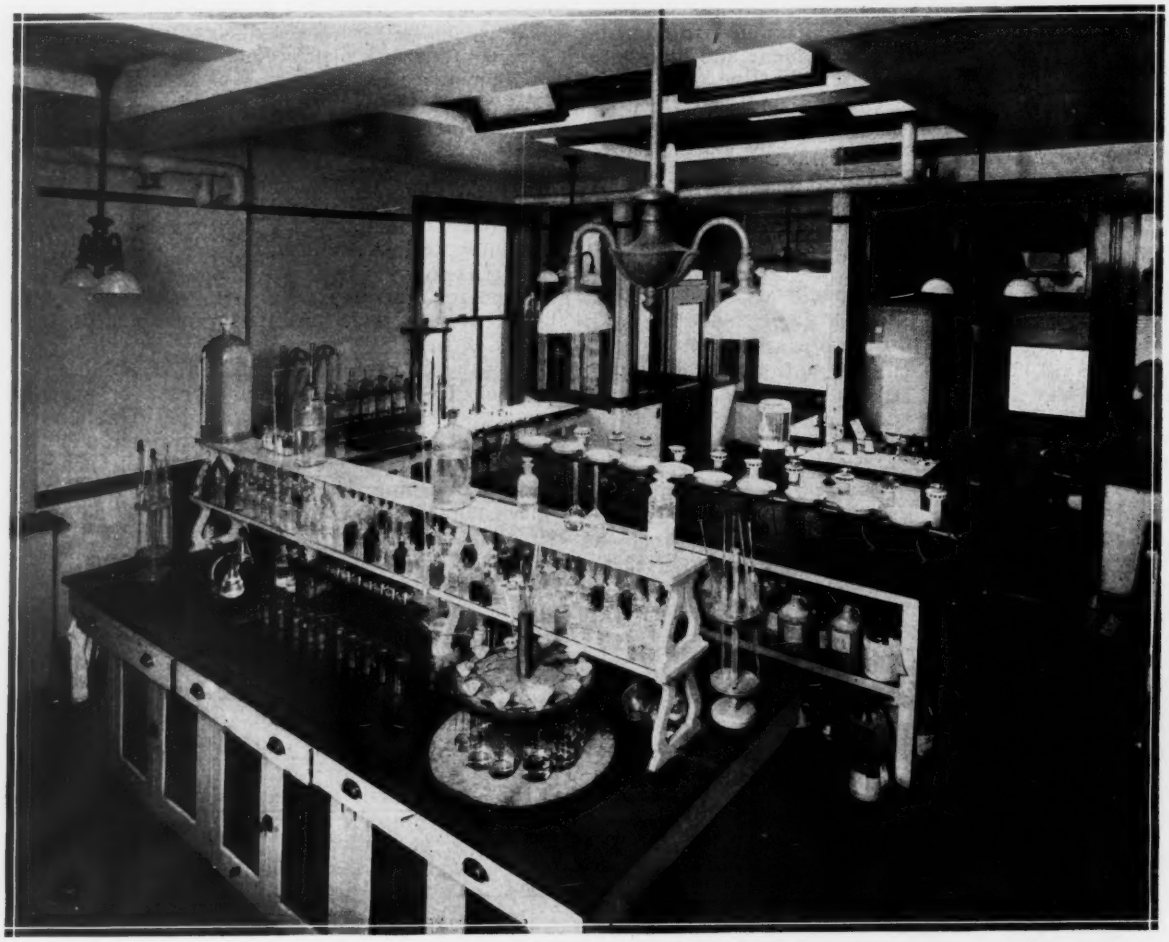


FIG. 1. LABORATORY WHERE BOILER FEED WATERS ARE ANALYZED

ufacturing plant for compounding and fixing of such preparations as are prescribed for each specific case from formulas constructed and furnished by the technical department.

Dearborn Methods of Treatment

DEARBORN methods consist of making a thorough and careful analysis of the feed water, thereby ascertaining the kinds of substances contained, and the quantity of each, thorough consideration by the engineering department of conditions existing in the

FIG. 2. CORNER OF THE OIL LABORATORY

plant, and finally the construction of a formula for treatment, the forwarding of such formula to the factory where the preparation is put together under the direct and personal supervision of those having a thorough knowledge of applied chemistry.

Treatments are prepared to neutralize the mineral ingredients and other objectionable constituents of the water, the percentage of each mineral salt governing the percentage of the antidote used. In badly coated boilers, scale composed principally of the salts

FIG. 3. FACTORY CONTROL LABORATORY

of lime, magnesia, silica and traces of aluminum, which are of a crystallizable nature, having an affinity for hot metal is converted into tannates, gallotannates and saccharates of lime, magnesia, etc., which are noncrystallizable, have no affinity for hot metal and are inert; these have the nature of oozy mud, and have not the specific gravity of water, so that there is no danger of this newly formed mud settling and causing a burning of the sheets by keeping the water from the iron.

In the conversion of scale into mud, disintegration takes place more rapidly in some parts than in others, extending through to the iron, so that when the boiler is cooled to a lower temperature, contraction throws off a part of this freshly converted scale, which although honeycombed, should be removed; therefore, in cleaning badly scaled boilers, tubular boilers should be washed every 7 to 10 days and water-tube boilers every 10 to 14 days for the first 30 to 60 days, or until the old scale has been pretty thoroughly removed.

Various boiler preparations are compounded and cooked in 6 large kettles, the 3 largest having a capacity of 30 barrels per batch, and the time required for each batch in mixing and cooking is from 4 to 8 hr. From the kettles, the mixture, when cooked, runs by gravity into the mixing tanks, which are located on the floor below. Additions of materials as may be necessary are then made and the entire product

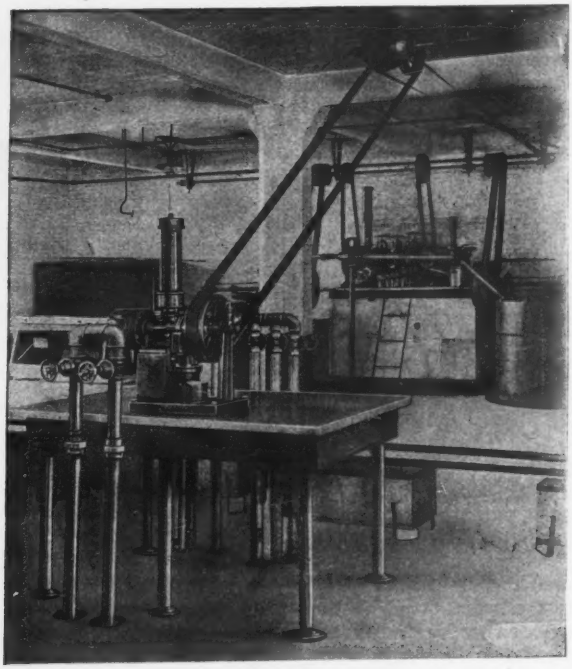


FIG. 6. GROUP OF BOWSER PUMPS AND MEASURES

thoroughly mixed by motor driven mechanical stirring apparatus, thus securing a complete and thorough mixture which would be difficult to accomplish, except by the use of such especially designed machinery.

From the mixers, the finished material is run into barrels or other containers, which are passed out on a continuous track and in passing out are painted such color as may be specified. The barrels or other containers finally reach the large platform scale where each one is weighed, inspected and stencilled, and is then ready for shipment.

Lubricating Oil Department

BEFORE beginning the manufacture of lubricating oils, the Dearborn Company made a series of tests, covering several years, of many grades of oil under

widely varying conditions, and accurate records of these results were kept. By this means the best oil for a specific purpose was determined. Upon filling orders for lubricating oils the exact conditions under which they are intended to be used are first ascertained; for example, if cylinder oil, the size and type of the engine, revolutions per minute, boiler pressure, etc. From previous records, a lubricant can then be selected adapted to the particular case.

In the oil storage house are 5 large, especially constructed steel storage tanks with a capacity of 20,000 gal., and several smaller tanks affording ample capacity for the many kinds of lubricating oils, giving an aggregate storage capacity of over 100,000 gal. The oil department contains facilities for blending, compounding and finishing for delivery 400 barrels of high class lubricants daily.

Most of the tanks in the blending and compounding department are equipped with mechanical motor-driven devices in which 2 or more oils can be thoroughly mixed. For oil that is compounded, and for many blended oils it is essential that the mixing be done at certain temperatures, considerably above that of the surrounding atmosphere, consequently several of these tanks are steam jacketed, and others are equipped with steam coils.

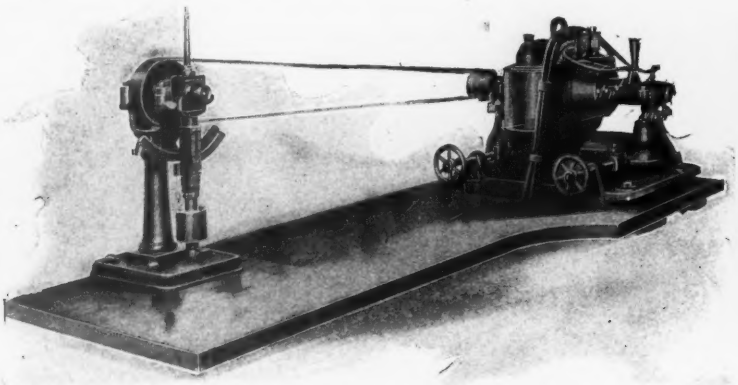


FIG. 4. MACHINE USED FOR DETERMINING THE FRICTION REDUCING POWER OF LUBRICANTS

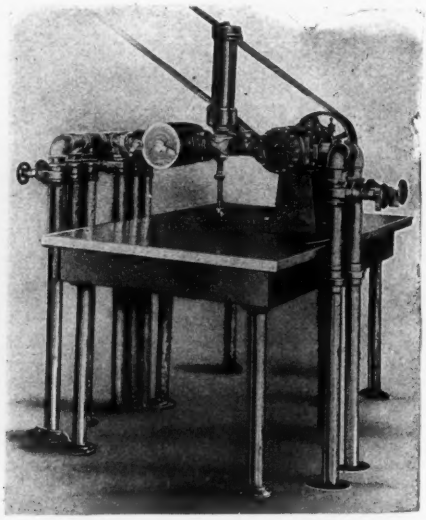
All the machinery in the lubricating department, as well as in the other departments of the factory, are driven by individual motors with direct drives, the power for which is supplied by the company's completely equipped power generating and heating plant.

Pumps and Measures

ALL of the tanks in the oil storage house are connected with the automatic pump and measuring devices for delivering oil to the compounding and blending department, located in the main building. This apparatus was installed by S. F. Bowser & Co., of Ft. Wayne, Ind., and includes several Bowser self-registering pipe line measures. The pumping and measuring devices are connected with the large storage tank by means of pipe lines and by a system of valves; any kind of oil may be pumped as wanted directly from the tanks to the mixing and blending tanks on another floor.

By setting the pipe line measures for the amount that it is desired to draw from the tank, that amount exactly will be pumped, the pump being automatically stopped when the amount at which the meter is set is delivered. The measures are so arranged that at the option of the operator any predetermined quantity, varying from 1 to 1,000 gal. can be accurately and rapidly delivered. When the amount has been discharged the flow automatically stops, and can be started again to duplicate any quantity. This latter feature is especially valuable when a number of barrels are to be filled with the same quantity of liquid.

To pump any predetermined quantity of liquid all that is necessary is to set the pointer on the dial at the proper amount, then push in the starting lever. Should it be necessary to stop the flow at any time before the predetermined amount has been discharged a small release lever on the measure may be touched, and the pumping ceases. A discharge point, no matter how far distant in the line, can be equipped with self-registering measures having the automatic starting and stopping device and the 2 may be operated at any distance. The operator at the point of discharge controls the pump the same as if he were alongside it.



G. 5. BOWSER SELF-REGISTERING PIPE LINE MEASURE AND PUMP

The system is so made that one or more may draw from the same pipe line at the same time, a different amount of liquid and each receive the exact predetermined quantity that he requires without the pump stopping work until the last measure records the amount wanted.

Bowser self-registering measures are designed to measure oil and similar liquids, but not water, as there is a vast difference between measuring water and this class of liquids. A meter designed to record the quantity of water going through it cannot be depended upon to measure lubricating oil accurately. In fact, there is little, if any, of the standard data on water meters which are of any use in measuring oils or heavy liquids.

An air release and strainer, consisting of a metal chamber, automatically separates any air in the pipe line from the liquid, and prevents foreign substances from entering the measure. In cases where the apparatus is subjected to low temperature, a steam jacket is provided so that steam heat can be applied to keep the liquid from thickening.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

Keeping a Stiff Backbone and Early Hours; Being Ready for What Does Happen or What Doesn't

MY DEAR SON DONALD:

I have your very welcome letter of a few days ago and I hasten to reply for the reason that you are to be congratulated that you pulled through that eventful day with all those petty little annoyances, without getting discouraged. At least, you didn't intimate in your letter that you were discouraged.

My son, there is nothing that leaves its stamp on a man so quick as discouragement and, if one refuses to become discouraged at the first onslaught, it is ten times easier to resist the temptation to become discouraged at each succeeding recurrence of a difficulty. I am really proud of you and so is mother. She says that you are just like her brother John (your Uncle), who could look the depths of adversity in the face and laugh at it.

I don't say but what you had your hands full that day when everything seemed to go wrong. Yes, now that you do speak of it, I do recall that I did write you about "troubles always coming in bunches," but that is some time ago and when a man gets to my age he is perhaps excusable if he does let a few little facts slip sometimes.

There is an old poem that I learned when I was a boy which has been a tonic to me many a time when the outlook seemed to be very dark and unpromising. These 2 lines always seemed to stand out more prominent than the rest of the piece and more than once when it has seemed that there was absolutely no way out of the difficulty at hand, I have repeated these lines over and over again till the dark clouds of adversity and discouragement seemed to roll back from above me, revealing a deep blue sky glistening with the power of hope and success.

Those lines are:

"'Tis all well enough to be pleasant when life goes by like a song,
But the man worth while, is the man with a smile when everything goes dead wrong."

Now Donny, boy, as you have weathered your first occasion to become discouraged without surrendering to it, I do not suppose that it will ever bother you again; but I wish that you would memorize these lines and if you see some other fellow that is becoming discouraged, repeat them to him. They may do him good. If you can help a downcast man to cheer up, you have made an everlasting friend, one who will stand the test of time.

Well, perhaps this is enough of this sermonizing. Still it seemed to be the proper thing to write to you at this time. However, my dear son, I am many times glad that when you had that day of unfortunate events, you successfully overcame them without drawing the fire. It makes no difference how long a man has been with a company, there is nothing that will set him back in the estimation of the firm like drawing the fires.

They have got their money invested in the factory and they want to get it out and as soon as the wheels stop, they at once begin to think that there is some one around the power end of the concern who does not know his business as well as it was thought that he did.

I am not saying that there are not times when it it necessary to draw them. That would be childish. But I am speaking in a general way, having in mind the possibility of knocking out the fire every time a thing goes wrong, and take all day to fix it. The main thing is to keep going and study how to take care of possible emergencies.

This may look to you perhaps, like borrowing trouble, but it isn't. There is a vast difference between reasoning and worrying. So there is a vast difference between studying over a possible emergency, and looking for trouble. You go around the rolling mills (and a number of other industries, but particularly the mills) and you will find almost enough spare parts beside each engine to make another one. Extra brasses, bearings, eccentric straps, wristplates, valve gear, and in fact all the parts liable to failure.

Blooming engines sometimes have a complete new shaft handy in case it is needed. Now this does not mean that they know the engine will break down every day. Perhaps none of these spare parts will be needed for years—maybe never—but it is simply a result of a good system of study and forethought to be prepared in this manner.

There is perhaps no place where time runs into money so fast as in a steel mill when the engine breaks down. So I am glad that you kept your head in the troublesome times, for if ever a man needs his head, it is when he has his hands full of trouble. Some fellows fly off the handle every time a waterglass breaks and rush around trying to do a little of everything, like an old hen which has just hatched out a setting of eggs and finds that they are all ducks.

But, to go back to that day's doings. Yes, I guess that you had your hands full for the day at least. I guess, by the way that you talk, that your Chief must be a very capable man, for you seem to tell me so much that he does, and if my experience is any good, he knows the coal-to-switchboard route with his eyes shut.

Of course you know that no matter what you do, if you are going to do well, it means work, and plenty of it. Anybody can be an engineer When Everything Runs All Right. It is not much of a trick to "handle" an engine. Every engine has a few tricks, like horses (and women), and when one learns the combination, it is not much of a trick to start and stop an engine.

But it takes an engineer to keep an engine in such shape that anyone can start and stop it. A man is no more an engineer because he twists a wheel or pulls a lever and the wheels move, than a man is a doctor because he can take a dose of castor oil or rub "Texas Liniment" on a sprained ankle.

I suppose that you have heard it said that, "A smooth sea never made a skillful mariner." This is mighty true, too. Any one can run a ship when the sun is shining and a spanking breeze on the "lubboard beam" but when the waves split on the end of the jib, climb over the "gunnels," and wash the galley "by the board," the canvas ripped to ribbons and the roar of "dead man's reef" on the quarter while the crash of the thunders of Heaven and the flash of the lightning sends sinners to their knees, then Donny boy, then is when it takes a sailor, and a good one to navigate a ship.

Any one can be an engineer as long as everything goes all right. All he has to do is to get the coal inside the fire door, keep the feed pump going, see that the damper is open as wide as it will go, fill the oil cups.

open the throttle (the way the book says to), and then, if the intense draft doesn't burn holes in the fire and let the cold air cool off the boiler, or if you don't get the fire banked or if you don't get the boiler so full of water that it will go over to the engine and knock out a head or two, or get so low that the tubes get hot and leak, or a check valve in the pump doesn't get balky or if the injector doesn't get hot and refuse to meet the emergency, or if you don't forget to fill the oil cups or the lubriactor or if the eccentric doesn't slip, or if the steam is not too high for the load, or the load too high for the steam, or the engine on the center when you try to start it, or one of the drop rods doesn't get loose and lengthen out, or if the packing doesn't blow out of the receiver pump (on the side next the wall), or the belt come off the generator or the circuit breaker throw out, or if any one of 1001 little things doesn't happen—why, then—then any one can be an engineer. It is just as simple as falling off a log when you once learn the trick.

But let me tell you my son, that you cannot learn the trick of running the works by making the professor believe that you are studying a new treatise on determining the heat units in a sample of coal up at "Teck" (as you call it), when in reality you are figuring out how you are going to take her to the theatre tonight, pay your month's board and three months tuition with the money you lost down in Casey's back room the night before on 3 Jacks.

It is hard enough to learn to be an engineer by means of the lead pencil route with all the attention that you can give to it, without giving the professor a little "blarney" so as to get a diploma. I am not trying to belittle a man with a technical education in his attempts to succeed along this or any other line but I do hate to see a man think that as soon as he gets a milk license with a gold seal in one corner, from some university, he has learned all there is to be learned about a profession, no matter what it is.

Well Donny, I have sort of wandered a little from what I started out to say, but I got so interested that I forgot time and place till mother called my attention to the fact that it was 9 o'clock and time to go to bed. But before I close, I want to say just a few more words in passing before I forgot it. I notice that you mention going to bed at ten. Well that is proper time. No man can do a satisfactory day's work, either for himself or for any one else if he is in the habit of neglecting his sleep. Then if he hastens matters by adding insult to injury and tries to drink the brewery dry, the effect is so much the worse.

I never posed as a radical reformer but I speak my mind right out as I feel. A man with his system all stirred up and out of whack from a "good time" the night before, cannot expect that when there is a chance in the works to promote some of the men to the position of foreman, they are going to select him for the job.

Of course I know that you do not use intoxicants. You would not be a MacDougal if you did and I have confidence in your horse sense. But I hope that you will never see ten o'clock at night. If you once get the habit of retiring at 9:30, you will never be troubled with insomnia, nervous prostration, or an installment collector.

So, my son, while I feel sort of "wound up," and would like to say much more, yet it will keep till another time. However, I feel that I must say a word about that "peach," that you mention. You are now some 26 or 27 and ought to know your own mind by this time and I hope that you will exercise the same horse sense in the matter of selecting a partner for life as you have in selecting a place of employment and I trust that you will not find that when you get your peach that you have got a Saturday night bargain basket with a few good ones on the surface.

Use the same care in selecting a woman that you would in selecting a boiler or engine, or a pump. Don't think that they are all the same and that the cheapest is the best. And when you do get her, treat her as you would your engine. In fact, an engine is a great deal like a woman; treat it pretty good and it will stay with you a long time.

Mother has just finshed you another pair of wool sox and will mail them to you in a few days. So my son, keep one side hot and the other side wet, and make your head save your heels. Good night.

Affectionately your father,
Sandy MacDougal.

NEW CENTRIFUGAL PUMP

Special Design of Runner on a New Operating Principle to Meet the Conditions of Steam Turbine Drive with Economy

TURBINE-driven centrifugal pumps of ordinary and turbine types operate most efficiently at speeds that are too low for best steam economies from the turbine, hence the speed of the combined unit must be a compromise.

Steam turbine drive for auxiliaries is popular on account of great reliability, no danger from overload,

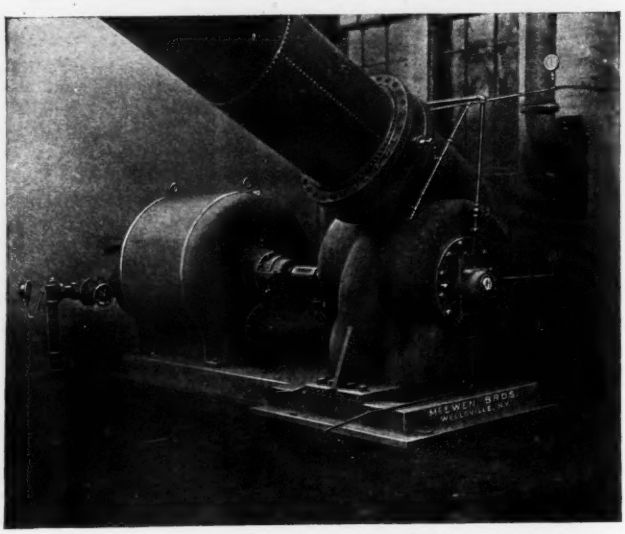


FIG. 1. McEWEN BROS. 30-IN. CENTRIFUGAL PUMP WITH 30,000 GAL. PER MINUTE CAPACITY

freedom from damage in case the discharge is choked, and the working parts protected by enclosure. The output is practically under constant speed and there is no noise or racking of pipe lines.

In view of the advantage of turbine drive as stated, it is only natural that pumps designed especially for direct-connection to turbines and with the economical speeds of one conforming more closely to those of the other, should prove desirable.

These are the conditions which the pumps made

by McEwen Bros., Wellsville, N. Y., and illustrated herewith, are designed to meet. The most notable feature of these pumps is the radical departure from the ordinary type of turbine runner, and the substitution therefor of a runner of either helical or propeller type, depending upon head and speed. The general construction is otherwise modified to meet the demands of high speed better, thus making a more efficient combined unit. The speed, however, is not too high for reliability, large turbo-alternators, for instance, operating at much higher speeds. Further, it is claimed that in addition to a comparatively much smaller pump, the greater economy permits the use of a smaller and less expensive turbine for doing a given work.

The horsepower required at constant pressure is said to vary nearly as the quantity of water pumped, and this eliminates the necessity of throttling under light loads. Also, the speed is said to be variable with good economy, which is an advantage in handling fluctuating demands.

As will be seen from the illustrations, the arrangements of the internal parts is unique. Water enters the suction inlet; flows in a spiral path through a volute suction passage; is parted to flow equally into each side of and naturally balance the impeller; is delivered from the periphery of the impeller into a volute outlet chamber and thence passed through the

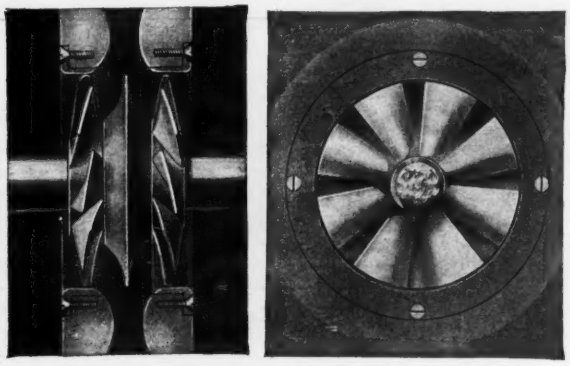


FIG. 2. PROPELLER TYPE OF RUNNER, INTERCHANGEABLE WITH HELICAL TYPE

discharge outlet. To compensate for possible inequalities and abnormal conditions, thrust collars are provided on the inner ends of the bearings. The impeller is allowed to find its own center during a running test, the collars are then set and thereafter hold the impeller in the position of highest efficiency.

The outer edges of the vanes are helices, while the main body of the impeller consists of 2 cone frustums with opposed bases. The water is thrown from the impeller at a velocity required by the head, and in streams which have parallel flow through the throat and annular nozzle into the volute, and the velocity there converted into pressure. With this design of impeller, the inlet area may extend from the hub to the outside diameter. Consequently, with equal inlet velocity and equal diameter of impeller, the larger delivery is made possible. In other words, as pressure is a function of diameter and speed, a smaller wheel may be used, and consequently higher speed, to deliver equal quantity at the same pressure. It should not be inferred from this, however, that the high speed of rotation necessitates high velocities in the discharge pipe. The velocity of the water at the outlet flange of these pumps is said to be usually lower, in no case is it higher than accepted practice, and the changes of velocity from the point of exit from the wheel to the discharge pipe is made smooth by careful design of the volute.

Where desirable to maintain steam turbine speeds at the low heads of 5 to 20 ft. the helical blades of the standard impeller are replaced by blades of the propeller type, which are really helical blades cut short and given an increased pitch to suit the head required. The cone body of the helical impeller serves as a deflector for the propeller. The 2 types of impeller are interchangeable in the same casing.

The interior of this pump is accessible without breaking pipe joints. Removal of the impeller involves

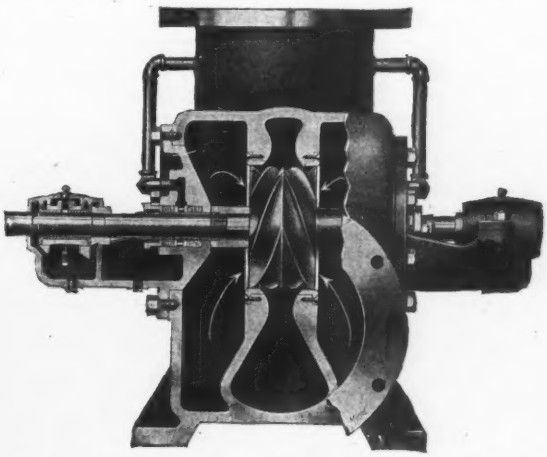


FIG. 3. SIDE ELEVATION SHOWING HELICAL TYPE OF RUNNER

only the breaking of a small ring joint and removing one bearing head. In this way, considerable less surface has to be packed against pressure and pumps may be located with small headroom as is usual in power houses, away from the service of cranes and with small side clearance. The weight of the parts to be handled, even in the largest sizes, is not excessive for manual labor.

The shell is cast in one piece, machined and provided with removable and cheaply renewable bronze wearing rings where the impeller runs close. Should these rings wear out, new rings can be put in to bring the pump back to standard efficiency. The impeller is made of bronze, finished all over, and is built up of 2 halves, symmetrical with reference to a plane perpendicular to the shaft axis, and the outer edges of the blades are machined to a running clearance with the wearing rings in the shell. The shaft is of nickel steel and entirely protected from the action of water by bronze protecting sleeves. Possibility of wear due to binding of packing at the stuffing gland is made unobjectionable as the wear comes on removable and cheaply renewable sleeves. The bearings are of the ring-oiling type, designed for very light pressures in order that the high rotative speeds will cause a minimum of friction loss. There is no possibility of oil mixing with water handled by the pump nor of water getting into the oil reservoirs.

WHEN A MAN has no good reason for doing a thing, he has one good reason for leaving it alone.—Walter Scott.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

TROUBLE IN A PUMPING PLANT

SOME years ago, while engaged as chief engineer in an irrigation pumping plant, a peculiar thing occurred several times, for which I never could account. The pump which was a 30-in Worthington centrifugal pump, running at 240 r. p. m., pulled by a Greenwald tandem compound condensing engine, 16 by 30 by 42, running at 90 r. p. m. Pump was guaranteed to throw 25,000 gal. p. m. and from numerous tests 30,000 was found to be delivered by the pump. Plant had then been received from the builders and had recently been erected. One morning, while feeling around the pump bearing,

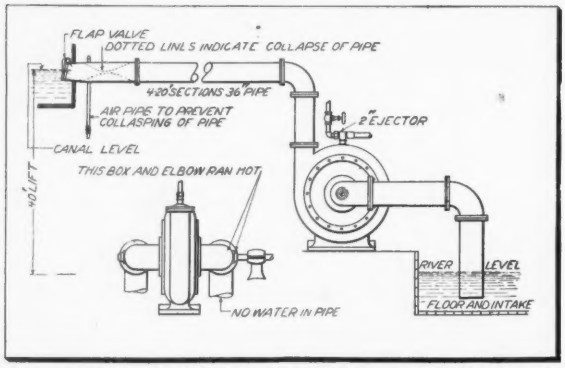


FIG. 1. PIPING ARRANGEMENT OF CENTRIFUGAL PUMP WHICH HAD HOT BEARING

I observed one of the bearings was running hot, something unusual, as it had never been hot before, and had been getting plenty of oil. I remained at the pump some time and finally found the elbow hot also, the bearing being located in the elbow and the shaft passing through it, the pump being equipped with 2 24-in. suction pipes, one on each side. The bearing and elbow on the other side being cool, and of the temperature of the river-water, I was somewhat puzzled at the time as everything in the plant was working nicely, boiler pressure 180 lb., receiver pressure 12 lb., vacuum 28 in., feed water 200 deg. F., the low duty pump to heater, condenser pump, boiler pump and fuel oil pump all working nicely, but the bearing still getting hot. I then noticed that the engine acted as though running light, cutting off early in the stroke, so I climbed up to the flume, and found only about half the usual amount of water was being discharged by the pump. I thought I had found the trouble with the pump and that the suction pipe was stopped up. The suction pipes not being equipped with foot valves, the water was raised with a 2-in. ejector. I got a long pole and ran it down along the suction pipe, expecting to find one of the floor planks in the bottom of the intake loose, and up under the suction pipe, but nothing wrong was found so I returned to the pump.

A small leak in steam pipe connection to the ejector on top of the pump caused the water to drop on the outside of the hot bearing.

The intake from the river was kept clean by a latice gate to keep out trash, etc., so nothing could pass into the pump, while at times a great many fish and crabs passed through pump and up into the canal.

The water was badly needed, some 3000 acres of land being planted in rice. I stopped the plant and again raised the water in the pump, when both suction pipes were cool. I ran the engine up to speed and kept it running, and the hot box was something of the past.

The same thing happened several times, but by stopping and again raising the water, the trouble was overcome. I never did know the cause; perhaps some of the readers can throw some light on it. From the accompanying sketch details of installations may be known.

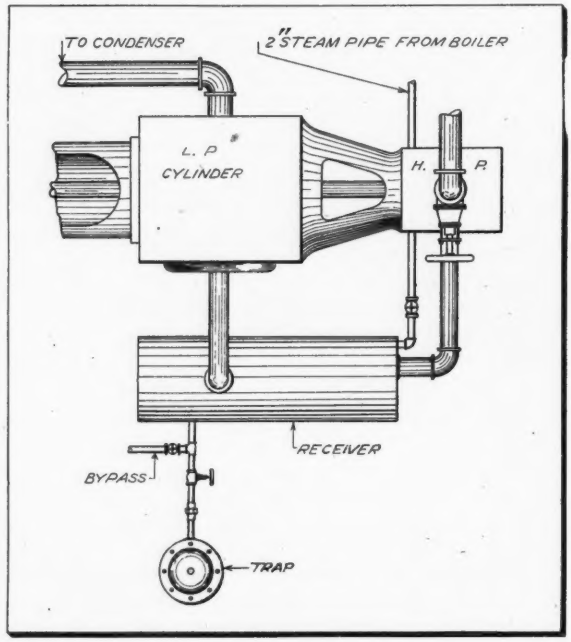


FIG. 2. RECEIVER PIPING

Once while packing the water end of the boiler feed pump (we had only one for this purpose) the follower plate was broken, a patch was made of a large door strap hinge and pump was alright.

Another time while we had plenty of water in the canal, we had stopped to change the suction pipe to fuel oil tank. The engine, however, made a move, stopped, and again moved part of a stroke. The fireman who had stopped the engine was sure he had closed the main throttle, and while talking about cause of the engine moving, I happened to look at the receiver gage, which indicated a pressure of 180 lb. The receiver was made of cast iron, with ends bolted on. We previously never had more than 30 lb. in the receiver when starting

the engines, before throwing on condenser. There was no time to waste, pressure had to be relieved when piping up trap to condenser.

I had been looking for future trouble, so had put a bypass in pipe line, which was intended to be used in case the trap should fail. The bypass could then be used and trap removed for repairs by disconnecting a union as shown in Fig. 2. I jumped down into the receiver pit and opened up the bypass. I did not remain long as I was anxious to get out. This was the only time this bypass was used. When the receiver pressure was relieved we hunted for the cause. From the steam main a 2-in. pipe was connected to receiver, a globe valve on this pipe was merely cracked open to maintain a pressure of 12 lb. in the receiver. With 180 lb. boiler pressure and 12 lb. receiver pressure the engine ran without undue noise.

While we were pumping night and day we usually stopped a few minutes, at 6 a. m. and 6 p. m., just long enough to fill the grease cup on the crank pin. One morning the night engineer stopped as usual, and while filling the grease cup he could hear the water from the flume rushing back into the river through the pump, he knew then that he had forgotten to drop the flap door on the end of discharge pipe. He loosened the rope, dropped the door and as a result the velocity of the water and the sudden vacuum created in discharge pipe, caused it to collapse, the pipe being a 36-in. riveted wrought iron pipe. This caused a shut down of one week, until a new pipe could be made. When this was put in I tapped a 1-in. pipe on top of discharge with a globe valve at bottom within reach. This valve was opened when shutting down, and permitted air to go in discharge pipe, as the water ran back through pump after the flap door was closed. C. Wilhelmsen.

SOME COMMENTS

IN the March number we find a description of an emergency "dash pot rod," by Mr. McGerry. Like Mr. Dixon I failed to see how, or what, was going to stop the valve from swinging beyond the reach of the hook, and perhaps going even far enough to open port on the opposite side of the valve. I do not approve of Mr. Dixon's system of running with the throttle while making the repair to the rod, for I've seen it tried, and it gave no satisfaction; besides it's dangerous, it shouldn't take very long to make the repairs he sets forth, in his arguments, and it is surely no crime to be down twenty minutes.

Another thing I wish to complain of, is the letters of Donald McDougal. Now, the boy is all right, and his letters are very clever as well as interesting, but I think that the boy is getting into one bad habit; he always has a big "me" and a little "other fellow," when he is advanced.

True it is that many are advanced for being better men, but I have always felt it wrong to belittle the man whom I superseded. All of us are more or less ignorant and some of us are not advanced because we have reached the limit of our brain capacity, and it always hurts a man bad enough, to find some one more able than he, without the better one throwing out hints that the man left at the post was a poor sprinter.

Some run faster than others, not because the others don't try, but simply because they are not built for running.

I want to answer "Student" also, in my humble way, as to what I would do now, if his trouble was to occur in my plant. It has occurred several times on engines under my care, and I have done several different things.

But the last time, or two that it happened, I discovered a way to do it somewhat differently. In case I found my piston rod loose and backing out, I would slowly close the throttle, until the engine was almost dead, and then unhooking the wrist plate, would leave the throttle cracked and hold head end valve open cushioning the piston as much as possible. Of course, since I always find and mark my clearance, I would screw the rod back into cross head, lock nut, and start up again. My failure to do the "cushioning" act lost me a cylinder head once, as the threads on the rod were slightly loose fitting, and, as both throttle and crank head valve leaked some, it slammed the piston against the head too far, and too hard.

John Pierce.

CRYSTALLIZATION

MANY breaks of bolts, studs, piston rods, etc., are due to the crystallization of the steel caused by strains of compression and elongation, pushing and pulling. A piece of mild machine steel will often in course of time so crystallize that it will look like a piece of tool steel, at place of fracture.

A great disadvantage of a built-up piston, is the danger of follower bolts becoming crystallized and breaking, the broken piece may slip through the exhaust valve and into the exhaust pipe, without doing damage; again it may not.

The writer once had a repair job, on an engine, which included replacing some broken studs in the crank end of the cylinder. Two had been broken off

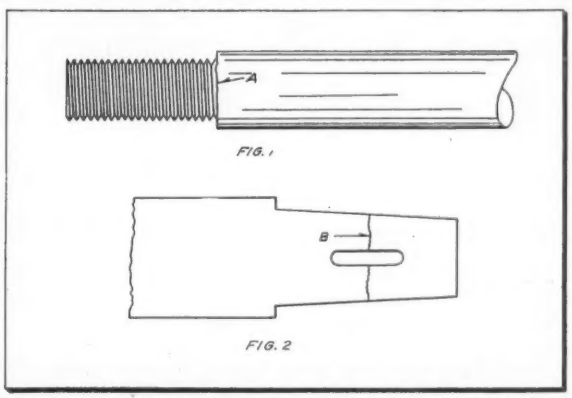


FIG. 1. LOCATION OF BREAK IN CRYSTALLIZED PISTON ROD
FIG. 2. BROKEN WEB DUE TO CRYSTALLIZATION

and the fracture was so much like the fracture of a coarse grade of tool steel that he decided to put in new studs all around.

A few years ago a 28 by 54-in. Corliss engine was put out of service for a couple of weeks by a break, due probably to the piston rod becoming crystallized. The rod was screwed into the crosshead and locked in place by a jam or lock nut against the crosshead. The break occurred at the end of the thread A, Fig. 1.

The piston shot back, breaking the cylinder head, snapping off about a dozen 1¼-in. studs, cracking the end of the cylinder. The piston was also broken. It proved to be quite an expensive repair job.

Piston rods held in place in crosshead by keys are apt to crystallize in the web B, Fig. 2 on the sides of the key way. Tom Jones.

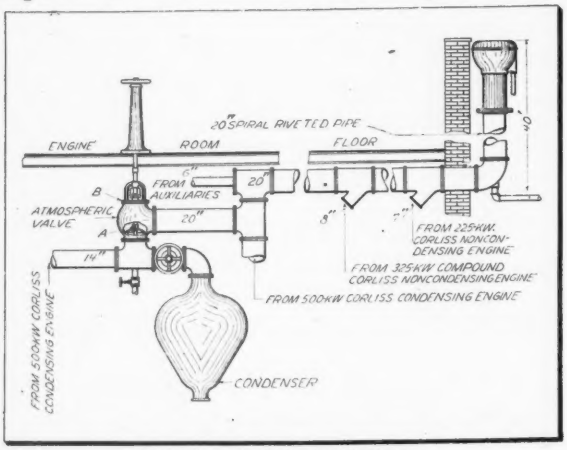
PUMPING WATER WITH GAS

DURING the recent drouth, our cooling pond got very low and for make up water we pumped from a well near by, with natural gas. Not having an air compressor of sufficient capacity, and the company owning its own gas wells, we lowered 100 ft. of ¾-in. pipe into the well and connected it to the high-pressure gas line. The well being a drilled well 652 ft. deep, 6 in. in diameter and water within 20 ft. of the surface we were able to get about 100 gal. a minute and kept up the supply until the drouth was broken. C. E. N.

TROUBLE WITH ATMOSPHERIC VALVE

THE sketch shows the exhaust piping from 2 500-kw. double eccentric, cross compound, Corliss condensing engines, and 2 spare Corliss engines, one a 325-kw. cross compound, and the other a 225-kw. single engine, also a 6-in. pipe leading from the auxiliaries after going through a closed heater.

We had trouble with our atmospheric valves, the brass valve stem was screwed into the valve disk at A and a pin put through as shown, the thread would strip and the pin shear after running noncondensing for any length of time. When this would happen the engine was shut down and the 325-kw. noncondensing engine started. While this was running we thought



EXHAUST PIPE ARRANGEMENT

we could not do anything to the atmospheric valve on account of exhaust steam backing up, until after the station was shut down at night and then hustled to get it fixed before starting up in the morning.

One day while we were short of boiler power, but could get along all right with the condensing engines running, the vacuum on one engine broke, and before the engineer got it back again the disk came off the stem, steam could not be kept up with the noncondensing engines running and something had to be done. The floor stand was removed, also the nuts from cap B, a rope was passed through the floor and fastened to the cap of the valve, everybody stood clear so as not to get burned, and the cap was pulled off, and to our surprise instead of exhaust steam coming up there was a nice cool breeze sucked in, which made it comfortable.

The valve was fixed in quick time and the engine put back into service. We had no more night work on the valves, as they could be fixed at any time during the day. In the meantime we found that although the double plunger dashpots used to work well when the engines were carrying their rated load, when the governor came down on the stop with an overload on, the dashpots would stick up, allowing steam to blow through into the condenser and break the vacuum. After new leathers and air valves were put in the dashpots, they would close at all loads, and we had no more condenser nor atmospheric valve troubles.

Thomas Sheehan.

OIL IN BOILERS

IN your issue of July 15 appears an article by John Pierce, under the caption: "Does oil cause a bagged boiler?" Evidently Mr. Pierce has told the strict truth as to the result of his experiments, yet the article, as it stands, contains matter full of danger for the young engineer. Mr. Pierce states that oil floats upon water. No doubt of this, if oil, as oil, is introduced to water, as water. But Mr. Pierce seems to lose sight of the fact that oil which has been atomized into steam will enter the water of condensation and form an emulsion, that is, the oil will be entirely distributed through the water so long as the water remains hot, separating only when the water has cooled to less than 100 deg. F. This is the form that cylinder oil assumes in all condensing plants where means for separating the oil from the exhaust steam are not employed.

Part of the oil can be extracted from the water of condensation by filtering through blanket, excelsior, horse hair, etc., but part of the oil will be carried into the boiler in emulsion, unless the water is cooled before filtering. Now, if this emulsified oil contains any animal or vegetable matter, or is made from stock having an asphaltum base, such as California oils, a deposit of carbon will be made upon the hot plates. Furthermore, it is a greasy sort of carbon, not unlike a coat of varnish. Water thrown on coating of this material has a tendency to roll around in drops instead of lying quietly upon it, especially when the plate is heated from below. Add to this the excellent heat insulating qualities of carbon, and you have a condition which produces a red-hot plate with very little delay. It is not necessary to have a heavy coating of oil on a plate to cause trouble, nor is the bag always local.

At a recent inspection of a horizontal tubular boiler in a heating plant, the hydrostatic test showed a slight leak at the girth seam, but the bottom of the boiler appeared true to the eye. On opening the boiler, the through stays in the bottom segment showed a decided bend, indicating that they were slack. Application of a straight-edge to the front sheet showed a depression of ¼ in. in a length of 6 ft. This swelling of the sheet extended about one-third of the circumference of the boiler. The entire fire sheet, as well as the tubes, was covered with a coat of carbonized oil about 1/32 in. thick, the accumulation from liberal lubrication of pump cylinders, lack of oil separation, and neglect.

Another recent case, likewise in a heating plant, resulted in a pocket about 8 in. across and ¼ in. deep. Here the engineer had been using a boiler compound to kill the oil and said that he had intended writing a testimonial of the virtue of that particular compound. The compound had destroyed the grease nature of the oil, but it couldn't destroy the carbon. This coating was less than 1/32 in. thick, the boiler was otherwise clean, but the pocket formed over the fire, nevertheless. Persistent use of the surface blow would probably have prevented the bag in this case, as combined oil will usually float before it sinks, and this boiler was examined fairly often.

In any case, however, fuel is too valuable to permit the waste of heat incidental to persistent surface

blowing, which would be necessary to insure safety in many cases. The use of oil as a scale-remover is valuable—but—be sure your oil is a pure mineral and is made from stock which has a paraffin base. Much, in fact, most, of the oil sold on the Pacific Coast is made from California stock, whose base is asphaltum, and this will surely deposit carbon on a hot plate. Cold oil will float, as Mr. Pierce has demonstrated, but oil under running conditions inside a boiler will frequently sink, causing collapsed furances and bagged shells.

F. L. Guptill.

I WOULD like to say a few words in regard to oil in steam boilers. In the July 15 issue there appear 2 articles, one by Mr. Duggan and the other by Mr. Pierce. These 2 gentlemen have altogether different opinions on the subject. Mr. Pierce's article is very interesting, indeed, and yet I do not agree with him at all. To start with I'll repeat a few of his lines: "The water on being blown out, naturally falls in the boiler shell and of course the oil naturally falls with it," also, "So that when the boiler is empty, and we knock in the heads, we find a film of oil on the shell and on the tubes." So far so good, now upon filling the boiler up again this film of oil stays where it was, not rising to top as he assumes. Now when fire is built and the shell is heated up the oil prevents the water from coming in contact with the plate and as a consequence that place is subjected to greater heat than the surrounding parts, results: the plate expands, its expansion is limited either way, so it naturally bulges, and as the pressure is on the inside it bulges out, thus forms a pocket.

It is true that oil floats, but I would like to see any one skim all the oil off of the water. Anybody can prove this for himself by dropping a few drops of oil in a tin cup full of water and then pouring the water out, and upon refilling the cup some oil is present yet; this can be repeated over and over for many times before the trace of oil is lost. Now the same conditions apply to boilers.

I agree with Mr. Duggan's statement that the only safe course to pursue is to prevent any oil whatsoever getting into the boiler. And furthermore I would like to state that an indifferent or intemperate fireman and oil in the boiler are alike dangerous.

Joseph J. Pire.

N reference to Mr. Pierce's article in the July 15 number regarding oil and lime in steam boilers, together with the causes of boiler bags and blisters, I wish to call attention to some of my experience in the U. S. Civil Service as an engineer.

Landing on the scene at the first appointment I found my boilers coated with lime from ⅜ to ½ in. thick, and the boiler pressure 100 lb. but the boilers were not forced.

I was afraid of the boilers, so reduced the pressure to 80 lb. which was barely enough to do the work. I notified the department of the conditions of the boilers; the answer I received was that that was a problem for the engineer. I drew a requisition for boiler compound but it was turned down. I installed a home-made appliance for feeding kerosene oil into the boiler, and in a few months my boilers were free from lime. The boilers were inspected, the test put on and the safety valves set up to 100 lb.; every thing went well.

I was transferred at an increase in salary to Ft. Totten, N. Dak. There cylinder oil and I got into trouble after every boiler in the plant had bagged. There was not a particle of lime in the boilers, but on the bottom of 1 boiler 66 in. by 16 ft. was a coat of cylinder oil. On the bottom of another a little to the right was another spot of oil the full length of the boiler sheet. The first boiler came down and blew a hole in the bag so it had to be patched. The second boiler bagged just where the spot of oil was, the bag being 3 ft. long. There was a full sheet from one of the boilers out in the back yard that had bagged the full length before I went there and the boiler had to be rolled out of the furnace and a new sheet put on.

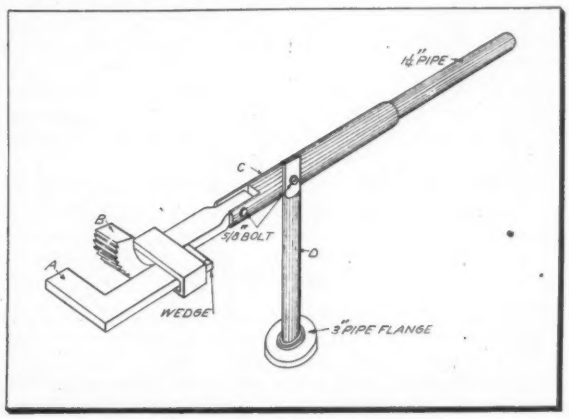
In my estimation the bagging of these boilers was due to an inefficient oil extractor. In regard to crude oil in boilers, this will not blister or bag a boiler, because the kerosene that is in the crude oil will cut the oil up and not let it settle on the sheets.

I have put potatoes and cylinder oil in boilers several times but I know the conditions of the boiler when I make the application. Cylinder oil, in my estimation, will not blister boilers unless the boilers are forced.

V. K. Stanley.

ENGINE JACK

I WISH to call attention to a slight error made in drawing the engine jack shown on page 729 of the July 15 issue. The part C should be made like a clevis as shown herewith, so that B can revolve part way



ENGINE JACK PROPERLY MADE

around upon the ⅝-in. bolt, thus making it retain a firm hold on the wheel through considerable space.

T. Ruffener.

DOES THE INDICATOR LIE

ON page 783 of August 1 number I notice a criticism of or rather an answer, to my desire for criticism, by J. C. Hawkins in regard to ⅝ and ¾ cutoff in single eccentric Corliss engines, and while I asked for practical and not theoretical explanations my disappointment can be imagined. He remarks that "in taking diagrams one must thoroughly understand the indicator and its use" which from his diagnosis and remarks on the subject under consideration he could most apropriately use. He states that the long cutoff was due to the return of the wrist plate closing the valve. Now this is entirely wrong as I will prove. First take the ¾ cutoff; it is barely possible that the wrist plate would close the valve as early as ¾ stroke if I had the eccentric set without regard to good practice, but how about the ⅝ cutoff which he says was also closed by the return of the wrist plate, now it takes a very badly mixed up valve setting to return a wrist plate at ⅝ stroke and cut off the steam unless one puts on steam lap with a "foot rule." Now cutoff

beyond ½ stroke with single eccentric is by no means new, but has been known ever since drop cutoff engines have been made and I was led to experiment on this line by the remarks of one of the best known practical writers on single and double eccentric Corliss and drop cutoff engines. W. E. Crane remarks in a recent mechanical magazine on valve setting: "When I added the second eccentric to Corliss engines over 25 yr. ago I was led to notice the effect of piston speed on the cutoff. I set the wrist plate on the center and splined the valves stems so that there should be the proper lead at that point and set the steam eccentric at a right angle to the crank expecting to get a cutoff at full ½ stroke and I was greatly surprised to find that the steam would follow fully ¾ stroke with no more than 550 ft. of piston speed, where the cutoff does not take place until nearly ½ stroke the piston at that point is traveling so fast that it arrives at ¾ stroke after the valves have tripped and before it could close as there is an interval of time after it trips before it closes even with a highly sensitive dashpot. This has been repeated on so many different engines that it is no longer an experiment or cause of wonder at the middle quarters the speed of the piston is so great that there is no dashpot quick enough to close the valve before the piston has traveled a considerable distance. It is advisable, however, where there are peak loads to have double eccentrics and eccentrics set back of 90 deg. for long cutoff and the valves always to trip so as to avoid steam blowing through into the exhaust when the steam valves are set with lead at both ends. It is not, however, necessary to have them set this way to get a long range of cutoff."

I am quoting the above excellent authority by way of explanation and support to my ¾ and ⅝ cutoff article.

A. C. Waldron.

BACK NUMBERS

N the July 1 issue of Practical Engineer John Pierce gives an interesting letter on back numbers, of which I have a few myself, and I am going to keep them as long as possible, as I often get good information from them, and I think it pays to keep them. I have right here a copy of the June issue of 1905, in which, on page 24, was an article worth, to me at least, a year's subscription. It contains a table of tap drill sizes for bolts and pipes, which I have failed to find in a number of engineers' reference books and which have been very useful.

On the same page one W. A. R. gives some advice about black varnish, and says that it is too expensive to make. I have used and always use around my boiler and engine rooms a varnish or enamel made of asphalt. Whenever there is any street repairing done in my neighborhod with asphalt I always try to get some from the wagon before it is mixed with sand, if possible. Simply warm it up over a slow fire, and a certain portion will melt away easily that has a sort of oily appearance. This I mix with gasoline, or benzine, and the varnish is made. It is good for anything, from boiler front to roof, has a nice lustre to it, and does not have the disagreeable odor that some ready mixed paints have, and does not burn off easily as coal tar does. I have painted roof and stack with it and do not want anything better. It can be bought for about 35 cents per gallon, but is generally adulterated with tar.

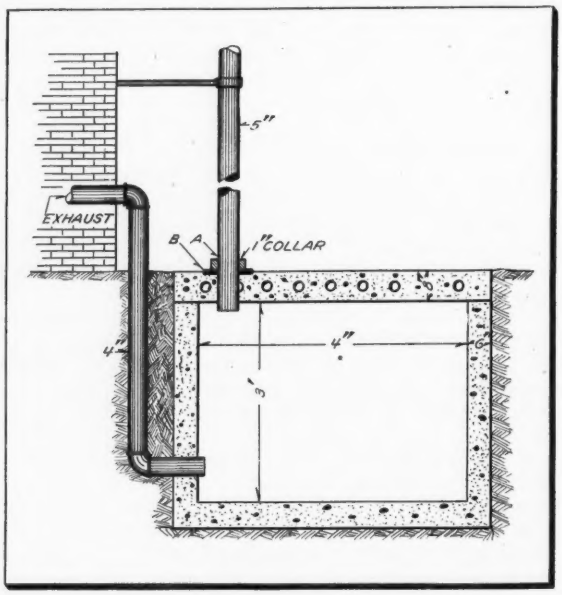
On another page C. H. says water columns should be renewed every 18 months. Why? If boilers are cleaned properly the column should be as good as the rest, and unless someone is lazy there should be no trouble with the columns, at least I have had none so far. I agree with J. Pierce as to some men being back numbers, as I recently approached one about reading Practical Engineer, and he simply said that the fellow that has to read a lot of papers and books to hold his job is no good, and never will be, but I notice that he plows along in the same old rut, and runs the same old rattletrap outfit that he had 10 yr. ago, and if he isn't a back number who is?

There is quite a difference between the issue of 1904 and 1912, as anyone who has a copy will soon see. The paper is constantly improving and getting better, and worth more all the time and certainly worth saving.

R. T.

MUFFLING PIT FOR GAS ENGINE

THE accompanying sketch shows a muffling pit which we have found very satisfactory and effective. The pit is just outside the engine room wall and is 3 ft. deep and 4 ft. square, the walls are of concrete, 6 in. thick and the cover is 8 in. thick, being reinforced with old boiler tubes to stiffen it up. The exhaust pipe from the engine is 4 in. in diameter while the pipe carrying the exhaust gases away from the pit is 5 in. in diameter, a 1-in. collar is shrunk on this pipe at A and this rests on a 15-in. plate, B, and at the top the



MUFFLING PIT FOR GAS ENGINE

pipe is braced to the engine room wall. When pouring the cover we placed a short piece of pipe in place of the outlet pipe and left it there till the cement had set. This has muffled the exhaust so effectively that it can hardly be heard when standing beside the pipe.

Our engines are all 3-cylinder vertical, rated at 100 hp. each, for a 500-hp. engine, the pit should be made to have an area of about 3 times the one shown here, as this is only large enough for 150 to 200-hp. engine. The first muffler was put in about 3 yr. ago and gave such satisfaction that the other engines were provided with mufflers of the same construction. Of course, several engines can exhaust in the same pit, if the pit is made in proportion to the horsepower it is to serve.

M. W. Utz.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Boiler Joints

CALKING a joint or seam is a simple matter when gone at in the proper way, but when the repair is undertaken in a careless fashion the leak usually gets worse. Some engineers use the round nose or fuller type of calking tool while others use the square nose tool; either will do the work. One form of tool, however, may be better suited to one job than another. There has been less harm done with the round nose tool than with the square pointed, as the square pointed tool not carefully handled will cut the under plate and may be the cause of a crack starting in the shell. Cracks have started from such on lap seam boilers. Fig. 1 shows a fuller pointed calking tool and the proper way of using it. We should not work too close to the plate that the lap is upon, while some will work this form of tool right down next to the plate for stop-

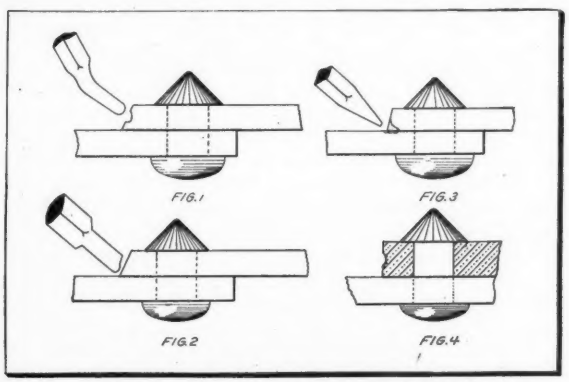


FIG. 1. ROUND NOSE OR FULLER TYPE CALKING TOOL
FIG. 2. SQUARE END CALKING TOOL
FIG. 3. POORLY CALKED JOINT
FIG. 4. PROPER METHOD OF CALKING CAST-IRON FLANGES

ping leaks you will find that to work it as shown will stop the leak quicker and in a more permanent way, by expanding the edge of the plate. Fig. 2 shows a good form of square end tool for calking next to shell plate having the corner slightly ground away so that in the process of calking you will not cut the under plate, or cut away the calking edge.

Figure 3 shows an example of a poorly calked joint. The use of a thin sharp tool will cut into the plate unless in the hands of an expert and the leaky joint will soon have the appearance of that shown in Fig. 3, the portion that has been calked will rust and eat away. Cast-iron flanges and parts may be successfully calked if done in the manner shown in Fig. 4, by the use of a fuller pointed tool the flange may be expanded so as to bring edge against the plate. We cannot, however, let our fullering tool come too far away from the surface of the steel shell nor can we drive in the joint with a sharp pointed calking tool, if we do the leaking joint will only get worse and it will be difficult to stop the leak at all.

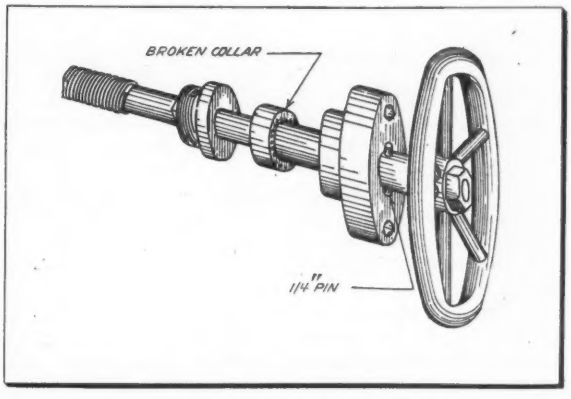
There is no piece of work around the power plant more difficult than calking a joint when the pressure is on and it should never be done if it can be avoided. Much care and judgment should be exercised when making the repair when the boilers are cool so as not to make the leak worse. Sometimes we will over calk a joint and cause it to get worse by throwing too much strain on the shell. C. R. McGahey.

Preventing a Shut Down

ONE day when firing up a boiler the fireman went up to cut it into the battery and I noticed that he was having trouble getting the valve opened. I looked at the steam gage and it was 10 lb. higher than the battery gages so I put out the fire (we burn oil), and went up to see what had happened.

It is a 4-in. gate valve with a stationary stem, that is, the stem does not move in and out of the stuffing box. When the boiler had been cut out the fireman must have closed it so tight as to break the collar off the stem as shown in cut by dotted lines.

He had the hand wheel off and was turning the stem with a monkey wrench. I took the wrench and turned the stem in the opposite direction from that in which he was turning it until it screwed out to its



EMERGENCY VALVE STEM REPAIR

proper place. Then telling him to go get a piece of ¼-in. rod I got my breast drill and drilled a ¼-in. hole in the valve stem close up to the packing gland.

Then cutting off the ¼-in. rod just long enough to pass between the studs which hold the gland, I drove the rod through the hole in the stem. This held the stem from screwing into the valve, thus enabling us to open it without any trouble. This happened about 6 months ago and the valve is still in use and it also prevented shutting down a 600-hp. plant, as the valve could not be replaced without shutting down all the other boilers. L. B. J.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Layout of Heating System

IN a building 120 ft. long we wish to place the radiators along one side. How can we connect them so as not to interfere with the doors?

2. We wish to make use of a boiler, that was formerly used for power purposes, for the heating system. How much pressure would we require?

3. How would you recommend securing feed water? When high-pressure steam was carried we used a feed-water pump, but with a few pounds of steam it will not work. We have no city water, but there is a tank about 15 ft. higher than the boiler. Will the tank supply the boiler?

4. Please explain how to connect up the radiators and where I should place a trap if needed.

5. We have 15 radiators built in 15 sections, 3 ft. high. Will they he sufficient to furnish the required heat?

6. What size pipe should be used from the boiler to end of the supply line? F. K.

A. Radiators may be connected as shown in sketch, with the main supply pipe running over the doors and the return pipe under the floor, or if radi-

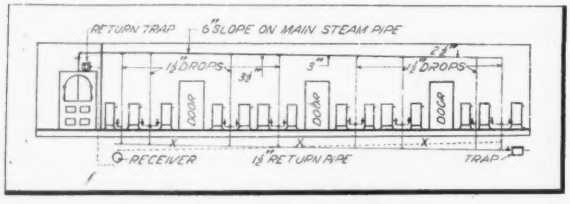


DIAGRAM OF HEATING SYSTEM

ators can be placed high enough over the floor, the return pipe might be laid on the floor with thresholds built over it at the doors.

2. Five or 10 lb. pressure of steam would do very nicely.

3. The water could be forced into the boiler by an injector which would be the most economical apparatus for that purpose in this case. The tank which is 15 ft. above the boiler might do it if the pressure did not go any higher than 5 lb., but it would be unsatisfactory as the water would run in slowly. An injector for the purpose would not be very expensive, but if one is bought, it should be one that is adapted to the work which it has to do. By submitting the proper data to the manufacturer of injectors, which includes the number and size of radiators to be supplied with steam and pressure used, you could get the injector which would be right for your case.

4. A steam trap or U-tube should be installed at the lowest point in the return line.

5. My table of temperatures in different localities gives a little lower average temperature in Milwaukee than in Boston. If the building was in Boston, the 15 radiators would heat it easily up to the living room temperature in zero weather and I think that, as the room is to be used as a shipping room, there will be no doubt but that the radiators will heat it warm enough for that purpose. Anyway, if the radiators will stand it, the pressure could be run higher on cold days as the radiators give off more heat with high than with low pressure.

6. The sizes of pipe are marked on the sketch, the main starting with 3½ in. pipe and running 40 ft. before reducing to 3 in. pipe and the running 40 ft. more to the 2½ in. pipe.

If you could get your returns back into the boiler, a great deal of heat would be saved. That could be done by using a return trap, such as the Bundy, Crane or Morehead, and letting the return pipe slant towards the boiler, and having it discharge into a larger pipe to act as a receiver and then from the bottom of that receiver up to the top of the boiler into the return trap.

It would be necessary to run 10 lb. pressure on the heating system if that was done. Of course that would cost more to install, but it would pay in the long run, and also be better for the boiler and more automatic as you would not be required to put in water as often, and when it was put in, it could be run direct from the tank to the return trap when it would be automatically forced into the boiler.

In the sketch, I have shown the supply drop pipes to supply 2 radiators each, by putting a cross in the drop pipe between 2 radiators and running both ways. Now, if there are 15 radiators in a distance of 120 ft., the distance between any 2 radiators will not be great, but I should place the 2 connected radiators as near together as possible and look out that there is no water pocket between the supply pipe and radiator because where the water is obliged to run back the same pipe in which the steam enters, it must be clear of water enough to give the steam room to pass by at all times. Make the pipe slant upward to the radiator a little if possible.

I have drawn in dotted lines, the connection and return pipe, which would be needed if the return trap is used. S. E. Balcom.

Refrigeration Questions

WILL you kindly advise the best way in which to run the cooler on an ice machine? Whether it should be kept half full of liquor or kept well pumped out. This question has caused considerable argument. Some say it works better with liquor in. I find it runs better when well pumped out.

Also kindly inform me what happens after the ammonia leaves expansion valve. Does it change into a gas or not? J. H. G.

A. We presume you refer to the accumulator on the flooded system, when you speak of the cooler on an ice machine. The level of liquid should be watched very carefully, and do not carry more than 14 to 20 in.

of liquid ammonia in the accumulator, as the nearer the level of liquid reaches the point of outlet from the accumulator, the more liable it is to be carried back to the machine. The less ammonia liquid in the accumulator, the better you can control the system, and consequently the better results you can get.

The simple experiment of evaporating a small quantity of anhydrous ammonia in a test bottle (where the conditions as to pressure are vastly more favorable for evaporating than those generally existing in refrigerating plants) convinces us, and should convince every operating engineer, that anhydrous ammonia can and does exist in its liquid state after having passed the "expansion valve." It will also show him that the intense cooling effect becomes apparent on only that portion of the surface which is in direct contact with the evaporating fluid itself, and not on that merely touched by expanding or expanded gas.

Ammonia, after passing through the expansion valve, is partly converted into gas; only that portion of the inner surface of the coil which is covered by, or continuously sprayed with liquid ammonia will be available for really efficient absorption of heat.

With top feed and bottom expansion, the liquid after passing the valve continues to flow along the inner surface of the coil until it is finally converted into a gas as in the dry compression system.

With the bottom feed as in the flooded system, and gradual progress in cooling, the coils or system of coils become gradually flooded, the admission of the refrigerant is so regulated as to make the quantity of the liquid supply exactly correspond in weight to that of the escaping vapor. W. H. Biesley.

Lowe Gas Apparatus

WHAT is the average amount of coke required per 1000 cu. ft. of gas and how much gas is there in 1 lb. of coke when burned in a Lowe water gas apparatus?

2. Should the heat in the carburettor and superheater look the same and what color should they be when ready for making gas. W. J. H.

A. The quantity of gas produced in a Lowe gas apparatus per lb. of coke depends on 3 factors, the relative length of period for the air and the steam flow, the quality of the coke, especially its carbon contents, and the quantity of oil used in the superheat for making the gas luminous. Without knowing at least the second and third of these, it is impossible to say what the quantity of gas should be. 40,000 cu. ft. of gas per ton of coke is generally considered good practice with the Lowe process. The carburettor and superheater should be a good red heat between 1200 and 1300 deg. F.

R. H. Fernald.

Strength of Boiler Seams

WHY is a longitudinal seam double riveted and the girth seam single riveted? Please explain fully. B. J. T.

A. The force tending to rupture the boiler, along the line of the longitudinal seams, is proportional to the diameter divided by 2, while the stress tending to pull it apart endways is only a half of that, or proportional to the diameter divided by 4.

To illustrate this properly, let the accompanying sketch represent the shell of a tubular boiler, without taking into consideration the tubes and braces which do not enter into the problem so far as the question in hand is concerned:

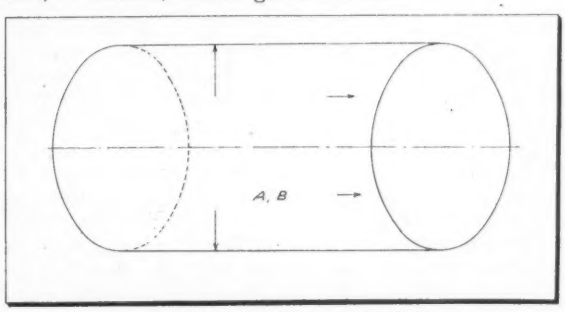
The total force tending to rupture the boiler along the line of the circumferential seams, as at the heads, or in the direction of the horizontal arrows, equals the area of one head in square inches times the pressure in pounds per square inch.

While the pressure is exerted against both heads, the area of only one can be considered for the reason that the 2 stresses are exerted against each other, the same as 2 men pulling against each other on a rope. The stress on the rope will be only what each man pulls, not what both pull. Let one of the men tie his end of the rope to a post and let the other man pull with the same stress as before. The total stress on the rope will be the same as when the 2 men opposed each other.

Suppose that the boiler in the sketch is 60 in. in diameter, and that it is subjected to a pressure of, say, 10 lb. per sq. in. The area of one head will be $60^2 \times .7854 = 2827.4$ sq. in. Then the total stress on the girth seams will be $2827.4 \times 10 = 28{,}274$ lb.

To resist this stress there is the entire circumference of the boiler which is $60 \times 3.1416 = 188.5$ in. Dividing the total pressure, 28,274 lb. by the circumference in inches, 188.5 gives 150 lb. as the stress on each lineal inch on the girth seam.

The stress on the longitudinal seams or along the line A B will be in the direction of the vertical arrows and will be pressure, 10 lb. times half the diameter, 30 inches, which gives 300 lb.



PRESSURE EXERTED IN BOILER

To find the bursting pressure of a boiler multiply the tensile strength of the sheets by the thickness in inches (decimally), and divide by the radius in inches. Assuming that the boiler in the sketch is constructed of sheets with tensile strength of 55,000 lbs. and that they are ⅜-in. thick, or, .375 in. We will also assume that there is no longitudinal seam in the boiler, for the present, and that the shell is one large seamless tube, like a section of large pipe.

In that case the longitudinal joint will be 100 per cent efficiency, and the bursting pressure will be $55{,}000 \times .375$ divided by $30 = 687.5$ lb. But as a certain percentage of the efficiency is lost in the construction of the longitudinal joint, due allowance must be made for this. We will not enter into the intricate detail of finding the efficiency of the various types of boiler joints at this time, only to state that a well designed double riveted longitudinal seam, figures out as approximately 70 per cent of the strength of the sheet itself, so that in the case at hand, the bursting pressure of a double riveted joint will be 70 per cent of the above bursting pressure, 687.5 lb. or 481 lb. Of course, with a factor of safety of 5, this will give a working pressure of 96 pounds, and the safety valve should be set to relieve at this point.

In case the horizontal joint is single riveted, use the decimal 0.56 instead of 0.70 and if it is a triple riveted butt and strap joint, use the decimal 0.88. In either case use a factor of safety of not less than 5.

G. H. Wallace.

Steam Problems and Answers

EXPLAIN cause of water hammer.

A. Aside from the priming of the boiler, water hammer in the steam or exhaust pipes of an engine is almost invariably due to faulty piping. By this we mean insufficient drainage; pockets, or drops below the general level of the pipe line. These should be avoided as far as possible, but in case it is absolutely necessary to put a drop in the line it should be thoroughly drained by a reliable steam trap. Water hammer often occurs when starting the engine, if the throttle is opened too suddenly, especially if the engine has not been running for several hours; during which time there has been no movement of steam in the steam pipe, and more or less water of condensation has accumulated therein.

In such cases the sudden opening of the throttle permits the steam to carry this water along with it, and the first obstruction in the shape of an elbow, or other deviation from a straight passage that it meets with will cause a sudden check in its course, resulting in a pound, or hammer. Water hammer in the pump is caused by insufficient air chamber capacity, or by allowing the air chamber to fill up with water, thus destroying all the air cushion.

2. If you make one governor rod longer and the other shorter, what effect will it have on the cutoff?

A. We presume that our correspondent refers to a governor of the Corliss type. Assuming that the cutoff is already equalized; the result of changing the lengths of the 2 rods which connect the governor with the releasing mechanism would be to cause a later cutoff on the end to which the shortened rod connects, and an earlier cutoff on the opposite end; although on some engines an opposite effect might result, depending upon the style of releasing mechanism, and the way it is connected. At any rate the effect of changing the length of the 2 rods would be to disarrange the cutoff.

3. If you had an engine with a shaft governor all apart, governor weights, spring, eccentric and valve on the flow, how would you proceed to set the valve, and give it proper lead?

A. No fixed rule can be given that will apply in all cases, owing to the fact that there are so many different types of shaft-governors. Speaking in a general way, the first thing on the program would be to place the valve in its proper location in the valve chest where it should be safe from possible injury. Next place the governor eccentric where it belongs, either on the engine shaft, or on the hub of the governor wheel which is keyed to the engine shaft, and then connect the weight arm, or arms.

Put the eccentric strap on, and after properly oiling the eccentric and other wearing surfaces, and before connecting the spring or springs it is a good plan to test the action of the weight arm, or arms, by moving them from inner to outer positions several times, the weights, of course, being in their proper counterbalanced condition, a man should be able to move them out and in easily with his hands, without the use of a bar of any kind. If the weight arms do not move freely it is an indication that something is binding too tightly; it may be the eccentric, eccentric strap, or perhaps the trouble may be in the pins to which the weight arms are connected. Whatever the trouble is, it should be remedied so that the arms will move in and out freely. When this is accomplished, connect the springs to the weight arms; next connect the eccentric rod to the strap, and to the rock shaft, or valve stem, as the case may be, and with the engine on dead center, and the governor weight arms at their inner position, adjust the valve for lead in the ordinary manner. Next test the valve for lap at each end of its travel, by first disconnecting the governor spring or springs, and with the weight arm, or arms blocked to their outer position turn the engine one complete revolution in the direction it is to run, observing at the same time whether or not the valve covers the parts at all points of the revolution. If it does not, the length of eccentric rod, or valve stem should be changed until the valve does cover the parts during a complete revolution when the weight arms of the governor are blocked to their extreme outer position. A very slight change is usually sufficient to accomplish this.

4. How could you tell if a tube in a closed heater was leaking?

A. In some types of closed feed water heaters using exhaust steam to heat the water, the steam passes through the tubes which are surrounded by water, while in other types the water fills the tubes which are in turn surrounded by the steam. In either case the water in a closed heater is under full boiler pressure while the feed pump is in operation, and if a leak started in one of the tubes the result would be an increased demand on the feed pump to supply the extra water which would be forced, either into the leaky tube, if the water surrounded the tubes, or into the shell of the heater if the water passed through the tubes. In either case the waste water would mingle with the exhaust steam, causing it to become very wet, much more so than it should be, and this condition would be noted at the discharged end of the exhaust pipe. C. F. Swingle.

Quantity of Feed Water

PLEASE advise the writer as to about how many gallons of water at 200 deg. F., boilers, each having a capacity of 150 hp. should use. They are run to their full capacity about 12 hr. per day; during the other 12 hr. they operate at about half capacity. We are at present using from 600 to 650 gal. per hr., how does this compare with your calculations? F. O. M.

A. A boiler horsepower is the evaporation of 34.5 pounds of water at 212 deg. F. into steam at atmospheric pressure, or its equivalent. As you do not say what steam pressure you carry, it is not possible to give you figures within about 5 per cent, but the answer will be very close, close enough for all ordinary purposes.

You have 2 boilers rated at 150 hp. or 300 boiler hp. in all. Then $300 \times 34.5 = 10350$ lb. of water evaporated per hour. Dividing this by 8.33, the weight in pounds of a gallon of water, gives 1253 gallons as the amount of water that the boilers should use per hour under full capacity.

You say that you are using from 600 to 650 gal. per hour, but we do not know whether this is the average for 24 hr. or the total for both boilers per hour, or the total for each boiler per hour. If this refers to the amount of water each boiler uses per hour during the 12 hr. full load period, it compares very favorably with the figures submitted by you in your inquiry.

G. H. Wallace.

THERE ARE 2 reasons why some people don't mind their own business. One is, that they haven't any business, and the other is, that they have no minds.—The Triumph Chronicle.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

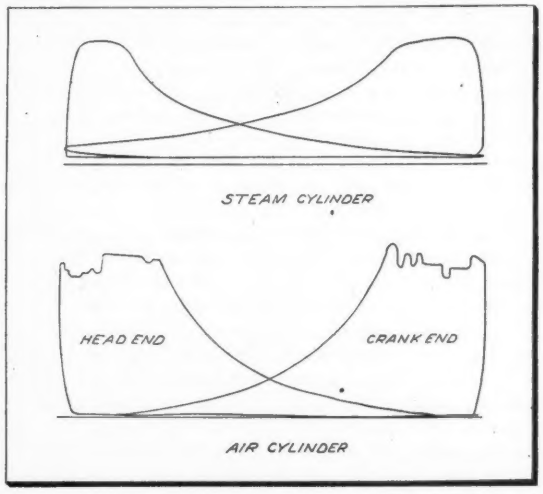
Fire Stream Problem

SHOULD be pleased to have some of the readers work the followig example on the slide rule and have the answers published:

A fire stream with 80 lb. tip pressure and hydrant pressure of 200 lb. flows through a 1½-in. nozzle. The hose is 200 ft. long and 2½ in. in diameter. What is the number of gallons a minute discharge? G. D.

Compressor Cards for Criticism

ACCOMPANYING 2 indicator diagrams were taken from steam and air cylinders of a steam-driven tandem-connected air compressor. The steam cylinder is about 32 yr. of age, has an old style crab claw steam hook on the Corliss valve gear; the cylinder is 20 by 48 in. stroke.



CARDS FROM THE STEAM AND AIR CYLINDERS OF AN AIR COMPRESSOR

Air cylinder is of Ingersoll-Rand make, with discharge valves in the heads and valves in the piston and piston rod. The cylinder is 22 by 48 in. stroke and water cooled. Should like to have the readers comment on these cards. C. E. Anderson.

Floating Bodies

ON page 793 of Practical Engineer, Aug. 1 issue, is the question, "Kindly explain the Laws of floating bodies." This is, I believe, the correct explanation: The principle of Archimedes is, that a body immersed in a liquid loses a weight equal to the weight of the liquid displaced. Therefore, a block of pine (density 0.5) will displace a volume of water equal to its own weight or the block will sink only one-half way down, since it weighs only one-half as much volume for volume.

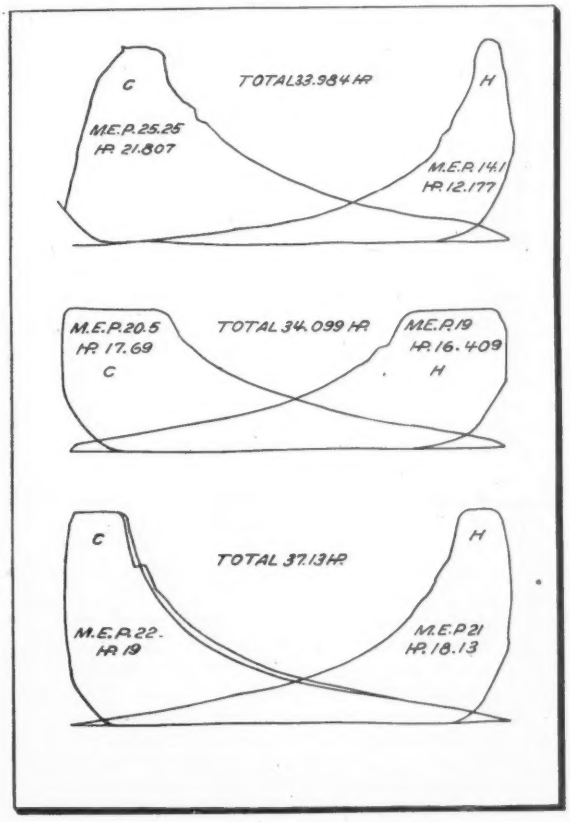
One cubic foot of water weighs 62 lb.; one cubic foot of pine weighs 31 lb., therefore, the pine has to displace 31 lb. of water or ½ cu. ft. If this same block was placed in alcohol it would sink deeper than in water, since alcohol is not as dense as water.

Iron weighs 7.84 times as much as water; therefore, 1 cu. ft. of iron weighs 486.08 lb., so the iron would not float. Aluminum is not as dense as mercury, therefore, the aluminum will float in the mercury.

H. M. Hastings.

Engine Cards for Criticism

I AM submitting some engine cards taken from an I. and E. Greenwald engine, showing changes made. A No. 40 spring was used. In this connection, I would state that I believe where a number of cards are taken it



ENGINE CARDS TO BE CRITICIZED

pays to use the engine constant in figuring the cards, in this case .86365 at 84 r. p. m. What do the readers think of the cards. Ellis G. King.

Cement for Leather Belts

I UNDERSTAND that there is a leather belt cement on the market that will join a leather belt and set so quickly that the belt may be used 30 min. after the splice is made. If any reader knows of such a cement I would like very much to get the name and address of the company selling it. Chas. Fenwick.

Location of Valves

IN answer to J. C. Hawkins' inquiry in Aug. 1 issue of Practical Engineer, I respectfully submit the following:

I would suggest that Mr. Hawkins arrange his valves as shown in the accompanying sketch. There should be an automatic non-return stop and check valve at the outlet of each boiler as shown, and a gate valve on each steam lead, placed next to the boiler header. This practice is followed out in modern boiler houses where safety is one of the main considerations.

Automatic valves should operate in either direction. For example: Should a tube blow out in the

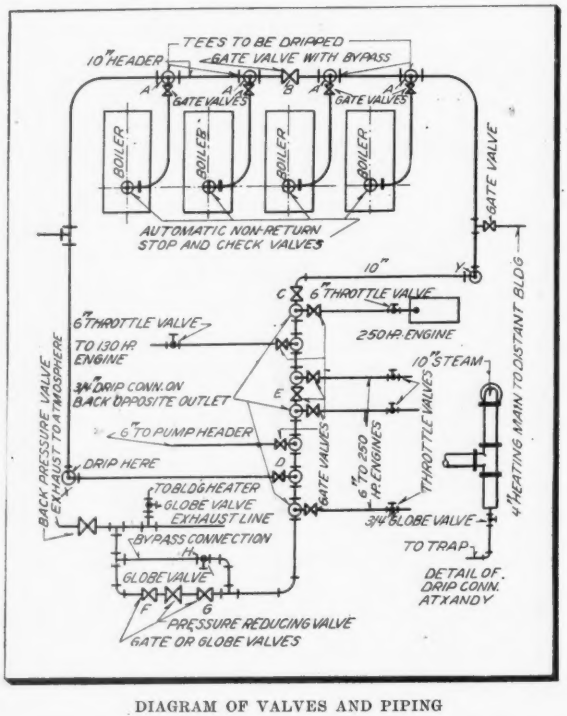


DIAGRAM OF VALVES AND PIPING

boiler the pressure in the steam header should automatically close the valve as soon as the pressure in the damaged boiler drops below that in the steam main, thus preventing the other boilers from emptying through the steam main into the damaged boiler and out through the ruptured tube. Then again, should a serious rupture occur some place in the steam main, suddenly releasing the pressure therein, the pressure in each boiler should act on the automatic valve, shutting off the flow of steam into the header, after which the safety valves should take care of any over-pressure in the boilers until the fires are drawn, or banked.

An automatic non-return stop and check valve, placed on each boiler outlet, as shown, does not add greatly to the cost of the system, and should an acident occur such as described, these valves will more than pay for themselves and probably be the means of saving the lives of the attendents.

It is better practice to carry the steam loads from each boiler into the top of the steam heads through an elbow and Tee, as shown at A, in preference to the side of the header as shown on Mr. Hawkins sketch. If desired to do so, thus saving the cost of the elbows, an angle valve could be placed directly on the inlet of each Tee at A. In this case the elbows, of course, would not be required. The gate valves in the steam loads, next the header, are for use in shutting down the line while repairing the automatic valves, should they get out of order.

Gate valves are shown in the main header placed at B, C, D and E, these valves are not absolutely necessary to succesful operation but will be found a convenience should it be desired at any time to shut off either branch of the loop system and carry the steam in one direction only. The valve at B divides the boiler header and valve E divides the engine header. With valves B, C, D and E, placed as shown, repairs or changes can be made in the piping system without shutting down the whole plant.

In addition to the throttle valve at each engine (ordinarily furnished with the engine) I have shown a gate valve in the steam lead from the header to the engine. These valves should be placed as close to the header as possible. It is advisable in all cases to take steam out of the top of the header rather than out of the side as this insures drier steam to the engines.

The pressure reducing valve supplying the heating system with live steam should be by-passed and this requires 3 valves as shown on the sketch. The valves F and G should be straight-way gate valves or globe valves as desired, but valve H should always be a globe valve as it is used as a throttle valve. Gate valves do not operate successfully as throttle valve as the disk chatters when only part way open. Ordinarily the valves F and G are open and valve H closed, permitting the steam to flow through the reducing valve into the heating system.

Should the reducing valve get out of order, however valves F and G can be closed while repairing the reducing valve, and live steam admitted through globe valve H as desired. I have shown a globe valve on the branch from the exhaust supplying heat to the building so the supply can be throttled by hand at this point. The exhaust line should be equipped with a back pressure valve, and from this point the exhaust chould be piped to the atmosphere. I should suggest that all valves larger than 6-in. in size be equipped with a by-pass connection on the valve body, to facilitate opening the valve against the unbalanced pressure acting on one side of the disk: The by-pass connection can be opened first admitting steam to the dead end of the line, equalizing the pressure and warming up the line, after which the main valve can be opened without difficulty. This also tends to prevent water hammer which frequently occurs when a valve is opened wide admitting a sudden rush of steam to the cold line without first warming it up slowly.

I have also shown drip-connections located at the low points of the system, and a larger size detail at points X and Y which shows a 10 in. drip leg with a ¾-in. connection to steam trap with the valves arranged as shown and the system properly drained free of condensation Mr. Hawkins should have no trouble with operation as far as the piping system is concerned. Wm. F. Fischer.

Proper Examinations

WILL you please give me the answers to the questions on Proper Examinations appearing in Practical Engineer of April 15, page 426? R. S.

A. Assuming that the check valve is in good condition; would stop the feed pump long enough to take bonnet off disabled feed valve, remove the valve, then replace the bonnet and start the pump, leaving the feed valves on the other 5 boilers wide open also, and regulate the speed of the feed pump accordingly. Under such conditions all the boilers should be fired as evenly as possible, in order that each may consume practically the same quantity of water.

2. (a) Return them to the manufacturers with orders to replace with tubes of the right length.

(b) Piece them out to the proper length by welding a piece of new tube on to one end of each.

3. Replace the old welts or straps by new ones of sufficient width to make a triple riveted butt joint of it on the cracked sheet.

4. (a) Pitch should be from 3⅓ to 3½ times the diameter of the rivet hole. Diameter of hole should be from 1 4/5 to 2 times the thickness of the plate.

(b) Diameter of rivet should be 1.8 times thickness of the sheet. Pitch 4.1 times diameter of hole.

5. Size of braces 1¼-in. round steel, or if made of flat bars of steel, sectional area should be the same as the round stays. Tensile strength to be 50,000 lb. per sq. in. in all cases. Number 15, area of safety valve should be, for a lever and weight valve, 1 sq. in. of valve area for each 2 sq. ft. of grate surface; and for a pop valve 1 sq. in. of valve area for each 3 sq. ft. of grate surface. If the boiler has 30 sq. ft. of grate surface it should have a 5 in. lever valve, or a 4 in. pop valve.

6. The action of the valves is interfered with and they will not perform their proper functions.

7. Such a condition may be due to several causes, as, for instance: (a) one or both of the steam valves may not seat properly owing to a too tight fitting connection with the valve stem; (b) too much back pressure from the exhaust system.

8. There will be a long drawn out blow of the exhaust from that end of the cylinder instead of a short sharp puff, as it should be.

9. Place the engine on the inner dead center (crank pin next the guides), then place one or more jacks under the boss of the crank in order that the weight of the shaft may be sustained by the jacks and not rest on the pillow block. Then disconnect the eccentric rod, mark the position of the eccentric on the shaft, loosen the eccentric and slide it along the shaft as far away from the pillow block as possible, in order to allow room to work around the pillow block. If the trouble is with the lower bearing, remove the cap and quarter boxes, dig out all the loose babbitt, first see that the box rests firmly in its place, and with the crank shaft in its proper position rebabbitt the bearing. Having gotten a good bearing underneath, ease up on the jacks until the shaft rests firmly upon it, then take the jacks out. If the babbitt is loose in the quarter boxes it should be taken out and repoured also. This can be done either on the shaft, or by the use of a mandrel having the same diameter as the shaft, the boxes being out on the floor. If the top box, or cap, needs rebabbitting it can be done with the cap in its place on the shaft. Having rebabbitted the pillow block in good shape, the engine should then be lined up, the eccentric placed in its old position and connected up, after which the engine is ready to run.

10. If the condenser is of the jet type, a force injection of cold water in addition to that supplied by the regular injection will assist in maintaining the vacuum to a certain extent, but it is expensive. If a surface condenser is in use and it is being worked to its full capacity, with the circulating pump and dry vacuum pump operating at full speed, all parts of the equipment doing their full quota of work, and still fail to maintain the vacuum, there is but one remedy, and that is to provide more condensing facilities.

11. If by "another eccentric" is meant an extra eccentric for operating the exhaust valves independent of the steam valves, the change would require an entirely new valve gear, including two wrist plates and two eccentrics. In adjusting the valves the wrist plates are first placed in their central position. Then adjust the lengths of the rods connecting the valve stem cranks with the wrist plates so that the steam valves are both open 11/32 in., and the exhaust valves are both lapped 3/16 in. Next place the engine on the dead center, and move the steam eccentric around on the shaft in the direction of rotation until the steam valve on that end has 1/32 in. lead; then make this eccentric fast. Now move the engine around in the direction it is to travel until it has made about 95 deg. of its stroke, and then move the exhaust eccentric around on the shaft until the exhaust valve on the same end is beginning to open or release. Make the exhaust eccentric fast, and move the engine around its full revolution and check off the valves on the other end and the exhaust closure.

12. When the pointer of the vacuum gage begins to drop back toward zero it shows that air is accumulating in the condenser. Would open the injection valve a little wider, and if air pump is independent would increase its speed slightly.

13. The advantages gained by the use of an automatic cut-off are, a better regulation of speed and the utilization of practically all the expansive force in the steam. A shaft governor should be located on the engine shaft at that point which will bring the eccentric in working line with the valve stem.

14. One or more boilers properly equipped. A steam main, risers and branches to the radiators. Radiator valves of the straightway type. Automatic air valves. Check valves. Hand operated air cocks. A sufficient number of radiators to supply the required number of sq. ft. of radiating surface. Steam traps. A feed pump for pumping the condensed water back into the boilers. In an exhaust system the steam traps would not be required.

15. Mainly by means of the exhaust valves and to a slight extent by the lead given the steam valves.

16. Would open the throttle, and injection valves very carefully, and endeavor to regulate the temperature of the condenser by feeling its side, admitting just enough injection water to keep the condenser cool, and yet prevent thumping caused by too heavy a flow of injection water.

C. F. Swingle.

LIQUEFIED GAS will be manufactured in Kansas City, Mo., within the next year for distribution in western Missouri and Kansas and will be offered in competition with the natural gas in Kansas City if the prices there are increased, as planned. A $3,000,000 southwestern corporation, with a West Virginia charter, is considering the purchase of 1 of 6 sites in Kansas City for the manufacture of liquefied gas. It is 1 of 8 similar corporations organized to build plants in different parts of the country.—Machinery.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Subscription Price One Dollar a year in advance to any Post Office in the United States or Mexico or United States possessions.

To Canada One Dollar and Seventy-five Cents; to Other Countries Two Dollars and Fifty Cents a year. Single copies 10 cents.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill. Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

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Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue, 22,500

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WANTED KEROSENE BURNERS

With the increased use of the gasoline engine for automobiles, motor boats, farm power and small power plants, the demand for gasoline has increased so that the supply cannot keep pace with it, and the constantly rising price gives warning that some substitute must be found. A few years ago, there was an agitation for the passage of the denatured alcohol bill, but the expected adaptation of alcohol for combustion engine fuel has not so far developed.

In the days when kerosene was the main household illuminant, the lighter products of petroleum were practically a drug on the market, and the price was correspondingly low. But with the rise of the small combustion engine, conditions have been reversed. Even on the farms gasoline is replacing kerosene as the source of light as the power plant and storage battery are introduced to replace the kerosene can and lamp. And so the study of kerosene as a source of power has taken on great importance as the price of gasoline goes up and the price of kerosene goes down.

The difficulty in using kerosene in the combustion engine has always been the vaporizing. Most of the attempts to produce a carbureter have used a hot vaporizer, and other methods have been based on a spray forced into the cylinder. Both introduce complications over the suction method of carburetion, and the development of the cold carburetion drawn in by the suction of the engine is a step in advance. It is necessary for the best interests of the small power engine that this development be furthered until kerosene engines in all sizes are as successful as the present gasoline engine; for a gasoline shortage is not so very far away.

OFF DUTY

Photographing Sound

Did you ever imagine just what the voice of the boss looks like when he is administering a sharp call down? You know what it sounds like, of course; at any rate we do. And it ought to look like a cartload of crosscut saws with a few hammers thrown in for good measure.

Well, that is just about what it does look like when you get a photograph of it. Yes, it is not only possible to see and to photograph the voice, but to study just the effect of every tone and emotion on the appearance of the voice. We saw it done.

Professor Miller explained how the wave from a tuning fork is a clean curve like the wave of current from an alternator, a sine curve, so called. Then a violin tone is like a smooth hill on one side and a pair of stairs on the other, because the string goes with the bow for a little (the smooth line) and then moves back against the bow in a series of quick jerks. They are some quick, too, for there are some 4000 of the complete waves per second.

These are very simple sounds, for a tone of a bell, or of the voice has all sorts of hills and hollows, big and little, to a single wave, and there are as many complete waves in a second as there are for the tuning fork or violin.

A phonograph or a graphophone or a Victrola or whatever name you may call it, is a mighty sensitive machine, for it records and reproduces these vibrations at their natural rate and gets every little jiggle so accurate that you can not only tell the sound, but even "his master's voice," and the kind of sound and the tone of voice depend on the number and kind of these little extra hills that are added to the general wave form.

The steam engine indicator is a pretty good piece of work in accurate instruments, but it is a good deal of an ox cart as compared to the "phonodike" which Prof. Miller has devised to record these sound waves. The little mirror is so small and so delicately hung that it takes up these 4000 waves a second and all their little hills and valleys, which make, nobody knows how many part swings a second, and records them by means of a revolving mirror on a photographic film or spreads them out into a series of waves that the eye can see and study. Yet that mirror, as to its weight, its length of swing, its bearings, is designed according to the same laws as the big 5000-hp. steam engine. From the herculean to the infinitesmal, Nature has definite laws, and from one extreme to the other, Man must work in accordance with them if he is to succeed.

Nitrogen Supply

While we are terribly concerned lest our coal or our lumber or our iron give out within the next thousand years, it has been only the scientists who have worried about the nitrogen supply. Yet nitrogen is more important than all the rest put together. It wouldn't be a terrible hardship to burn other fuel than coal,—peat, for instance; and if necessity mothered hard enough some genius would find a way to snatch power from tides, waves and sunshine. And as to lumber, we are getting away from its use as fast as we can anyhow, and when the pinch gets hard enough, we shall grow more the same as we do corn,—if we have nitrogen.

Just now Chile has us by the stomach, for if its nitrogen supply were refused to the world, the fertilizing of food crops would be a serious problem. Also the manufacture of gunpowder, firecrackers, topedoes and fireworks might be annihilated, at which prospect we feel quite complaisant.

But the ridiculous thing would be for us to sit idly and see the crops fail while the air above and the subsoil below are filled, just literally packed full, of the indispensable nitrogen. From below, we may concentrate it only by plant action of such deep rooted crops as clovers, alfalfa, peas, vetches and the like. From the air we may draw a boundless supply if we can but find a means to fix it. Above one square mile of the Earth's surface is some 22,000,000 tons, or a 50 years' supply. So again, what we need is the genius to apply the method.

Cheap electric power in large quantities is the essential in methods thus far devised. One in Norway uses the electric furnace in producing Norway saltpeter; the other, an American process, produces cyanamide, a nitrogenous fertilizer, in connection with calcium carbide manufacture of acetylene gas production.

And so there is hope for us that nitrogen may be available for growing our daily breakfast food for some time yet, even if Chile's saltpeter should peter out.

Of course there is the possibility that when everybody has resorted to intensive farming and is raising sufficient to support the family, to say nothing of keep the cow in the space between the front door step and the sidewalk, the demand for nitrogen may exhaust the air to such an extent that all will burn up on the concentrated oxygen; but let's not try to anticipate all the worries of the next 20 centuries, for if we rob future generations of their rights by not conserving natural resources, we ought to leave them at least their tribulations to pass away the time.

POSSIBLE FRAUDS IN AIR COMPRESSOR TESTS

IN a recent issue of the Electric Review suggestions are made how it would be possible for an air compressor builder to convey an incorrect impression as to the efficiency of his machine.

In conducting air compressor tests, it says, the method usually adopted is to measure the time taken to pump a reservoir of known capacity up to a given pressure, or to require the compressor to maintain a given pressure when the air is escaping through a sharp edged orifice of known size. In both cases the temperature of the air in the reservoir should be noted, and this cannot be measured by holding a thermometer in the issuing jet, when the orifice method of test is used.

When the output of a compressor is being gaged by the pressure maintained behind a sharp edged orifice, it is the inspector's duty not merely to measure the orifice, but to satisfy himself that there is no obstruction, temporary or otherwise, to the free flow of air to the orifice.

When the reservoir test is being conducted, the usual method of fraud consists in having a quantity of water in the reservoir, thus reducing its capacity and shortening the time required to raise the air it contains to the specified pressure. The presence of water cannot easily be detected if the drain cock is fitted with an internal pipe terminating at a point above the bottom of the reservoir, so that the air is always drawn from the cock when it is opened.

Another method, largely practical when there are duplicate reservoirs, as in battleships, consists of slightly opening a junction valve for a few minutes and allowing air from another reservoir to enter the one to which the compressor is connected. By this means the compressor is helped to the desired extent, and if the trick is carried out unobserved, it is difficult of detection, as the gage readings are not fine enough to make the transaction readily visible.

Compressor builders will doubtless be duly grateful to their electric co-workers for these business suggestions.

IN THE EDITORIAL on Standards, Aug. 15 issue, the reference in next to the last paragraph was to a 16 by 6 in. tee; not a 16 by 16 in. as the printer made it read.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

IMPROVED NON-RETURN SAFETY BOILER STOP VALVE

IMPORTANCE of non-return boiler stop valves for use on a battery of boilers is universally acknowledged, and in some countries their installation is compulsory. It is evident that should a tube be blown out or a fitting ruptured in one of the boilers of a battery, the steam from the other boilers would rush into the header and discharge into the disabled one. An ordinary stop valve would here be inadequate, as considerable time would necessarily be consumed in reaching and closing the valve, and a certain amount of danger must be anticipated. The non-return safety boiler stop valve shown herewith has been given very severe tests, and is in use in a large number of high-pressure power plants in all cases giving perfect satisfaction.

Figure 1 shows this improved valve applied to a battery of boilers in the plant of The New York Rubber Company, Matteawan, N. Y., Fig. 2, a vertical section of the valve parallel to the pipe, and Fig. 3, a section at right angles to the pipe. When these valves are used, should an accident occur, such as the blowing out of a tube in the boiler or any rupture of the headers, shells, etc., permitting the steam to escape, the valve attached to that boiler will immediately close. This will prevent the escape of steam from the other boilers connected with it in battery, and the danger

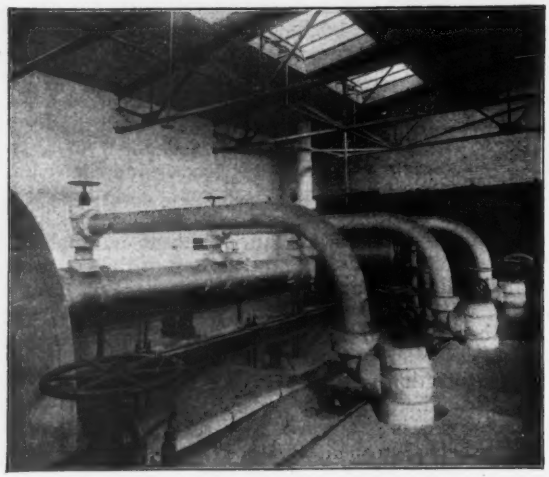


FIG. 1. BATTERY OF BOILERS EQUIPPED WITH NON-RETURN VALVES

to life and property will be greatly lessened. The plant can be operated with the other boiler or boilers, without interference, thereby preventing a shut down and the loss of time and money.

This valve will prevent steam from being turned into a boiler which has been cut out for cleaning or repairs, as it cannot be opened by hand when pressure is on the header side. It can, however, be closed when desired. The valve can be connected in either horizontal or vertical position.

A unique arrangement of outside spring and lever mechanism has been provided for the purpose of effecting a slight counter-balancing effect to hold the valve open, this being necessary in order to counteract the influences within the valve or line which tend to actuate the disc with every slight fluctuation of pressure. These fluctuations, usually caused by the engine, are frequently met within steam lines, and unless some means, such as are shown in this construction, are applied for counteracting these pulsations, the disc will be kept in continual motion, and with the lack of lubrication within the dash-pot, rapid wear will soon take place, causing a clearance between the piston and the dash-pot. As the amount of clearance increases,

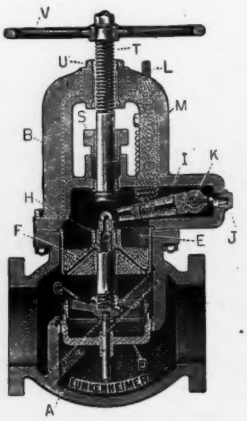


FIG. 2. SECTION OF NON-RETURN VALVE PARALLEL TO PIPE

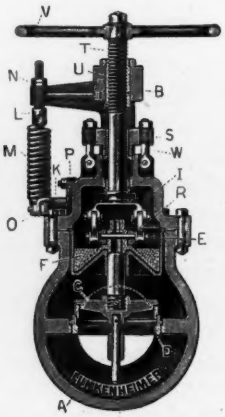


FIG. 3. SECTION OF VALVE AT RIGHT ANGLES TO PIPE

the dash-pot becomes less effective and chattering soon results, causing great damage to the internal parts of the valve. Where the fluctuations of pressure do not exist, and the flow of steam is steady, the use of the exterior spring and lever mechanism is not necessary. Hence, the valves are regularly furnished without tension on the spring, and the dash-pot arrangement can here be depended upon to cushion the movement of the disc.

Should a pulsating condition develop, which can easily be detected by observing the movement of the spindle L, the regulating nuts N can be adjusted, gradually placing the spring under tension, until the rapid movement of the spindle L is stopped. This adjustment of the nuts tends to lift the disc from its seat as it places the spring under tension, causing it to pull upon the lever O. This lever is keyed to the

shaft K, which shaft enters the valve through the stuffing-box P. Attached to the shaft O is the forked arm I, to which are pivoted the links R, which in turn, are loosely connected to the piston F. When the spring is under tension, the disc is raised from its seat and cannot close until the steam pressure above the disc exceeds that under it. This difference in pressure, which is governed by the tension of the spring, is never more than 5 lb.

When the valve is properly set to overcome the tendency of pulsation, the disc remains practically in equilibrium until there is a reduction in pressure on the inlet side, when it will instantly close. Attention is called to the large bearing surface of the piston within the dash-pot. All parts of the valve subjected to wear are renewable, and this includes the disc and seat ring, though the seating faces of the disc and seat ring can be reground a number of times before it is necessary to renew these parts. The stuffing-box, through which the stem T travels, is of large size and entirely exposed to the cooling effects of the air. It can be packed under pressure when the stem is raised to its limit, as a shoulder on the bottom of the stem forms a seat against the bronze bushing in the bottom of the stuffing-box. The stem T operates in the bronze hub U in the top of the yoke and bronze bushings in the gland and stuffing-box, thereby preventing corrosion and insuring easy operation. These valves are made in 5 different combinations of materials in order to suit the requirements of various conditions of superheat and high pressure, and also to meet the specifications of engineers who may differ as to what is best suited to the purpose. The Lunkenheimer Co., of Cincinnati, Ohio, are the manufacturers of these valves.

MOREHEAD CONDENSER TRAP

ONE of the new products of the Morehead Canadian Co. is the condenser trap designed for use on low pressure and exhaust steam lines. This device is in general appearance similar to the old Morehead return steam trap. In detail, however, the condenser trap differs from the return trap in the addition of a cold water connection made through a

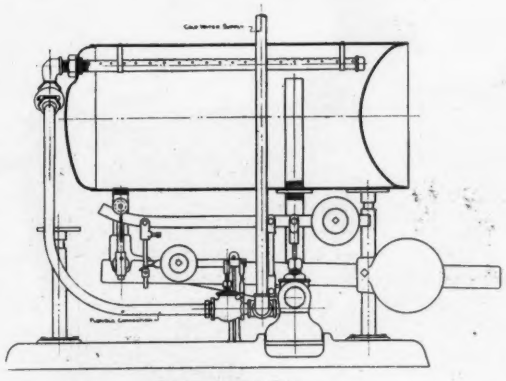


FIG. 1. DIAGRAM OF MOREHEAD CONDENSER TRAP

flexible tube with the tank of the trap. The flexible connection terminates in a perforated pipe inside of and running the length of the trap tank. In short, the condenser trap is nothing more or less than a combination of the principles of the jet condenser and the Morehead automatic return steam trap.

The condenser trap is held to dispense with the use of vacuum valves and pumps continuously used on heating systems, and it may be installed at less cost than the others.

Connected to the return line of vacuum heating systems where a difference of pressure is maintained between the ends of the system the line condensation and accumulating air is taken into the tank of the condenser trap as in the case of the return trap, but with the added pulling power of the vacuum created in the tank of the condenser trap.

When the steam is turned on in the heating system, the various lines of which are full of air, the cold water supply valve as shown in the sectional view of the trap is opened slightly. As the condensation from the return lines and the condensing water fills the tank the latter tilts, opening the live steam valve, allowing the steam pressure to enter and discharge the water contents into a return steam trap above the boiler or into an open heater.

As soon as the water is discharged, the tank, containing the steam which is left after the water is discharged, resumes a horizontal or filling position. The tank returning to its horizontal position automatically opens the control valve on the cold water inlet and allows the cold water spray to come in con-

FIG. 2. MOREHEAD CONDENSER TRAP IN USE ON HEATING SYSTEM

tact with the live steam contained in the tank. This cold water condenses the steam and forms a vacuum in the tank of the trap which in turn performs the usual functions of created vacuum in heating systems, of pulling the condensation from the lines to be drained.

The cold water supply is furnished either from city water works or a tank or other source that is available for that purpose. Particular attention is called to the fact that a small amount of water is required in the condensing process.

A receiver is always used in connection with the condenser trap, the water seal in the receiver taking the place of thermostatic valves on the heating system. The condenser trap is used as the lower trap, taking the place of the return trap in the Morehead standard double trap installation, the lower or condenser trap discharging to the return trap placed above the boiler.

GOULDS NEW TRIPLEX PUMPS

Newly Developed Power Pumps for General Water Supply and Pressure Service

ILLUSTRATIONS herewith show 2 new types of triplex pumps known as Figs. 1590 and 1596, that have just been developed by the Goulds Mfg. Company of Seneca Falls, N. Y. Both are of the single gear type, and are provided with an extended pinion shaft for pulley or direct connection to the prime mover.

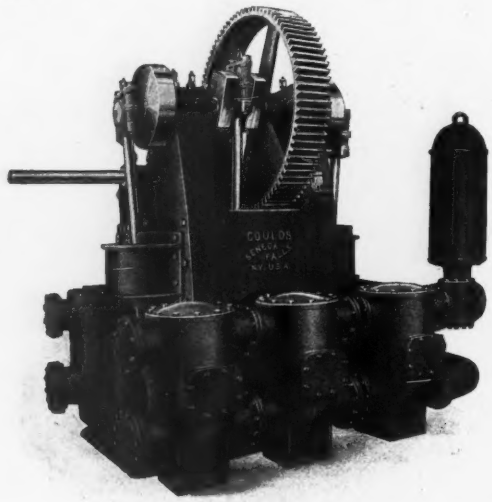


FIG. 1. GOULDS FIGURE 1590 DOUBLE-ACTING TRIPLEX PUMP

Figure 1590 is a double-acting triplex piston pump built in capacities varying from 10,500 to 91,500 gal. per hour, and for pressures up to 150 lb. or 350 ft. elevation. It is suitable for general water supply, municipal water works, fire, sprinkler systems, hydraulic elevators and similar services.

Figure 1596 is a single-acting triplex plunger pump

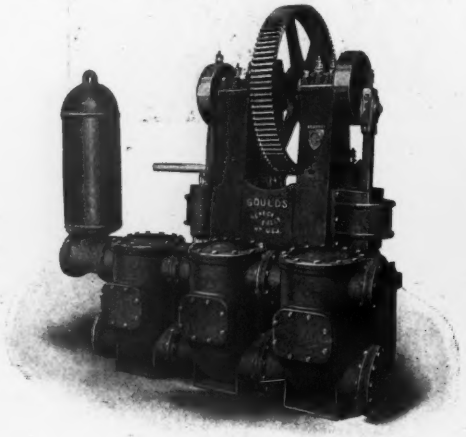


FIG. 2. GOULDS FIGURE 1596 SINGLE-ACTING TRIPLEX PUMP

built in capacities ranging from 25,680 to 57,600 gal. per hour, and for pressures up to 100 lb. or 230 ft. elevation. It is suitable for all services where large quantities of water are required against moderate pressures as for condenser, general water supply and similar services.

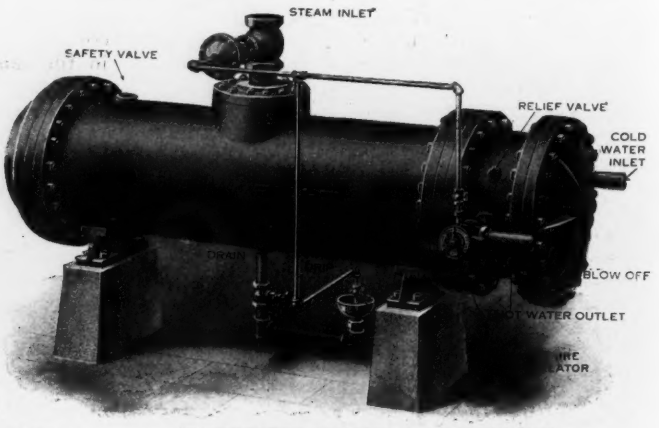
WAINWRIGHT DOMESTIC WATER HEATER

OF reecnt development, is a new type of domestic water heater which is designed particularly to fulfill the requirements of the hot water plant in which the service is intermittent and a constant temperature of the water is desired. The water systems of hotels, hospitals, penal institutions, and public baths are examples of typical installations of such plants.

In such installations as the first three mentioned, almost invariably there are generating units for furnishing light and power, and the hot water load is but a small part of the total load, so that there is sufficient exhaust steam for heating the water as it is drawn. In the gymnasiums and public baths, the hot water load is practically the total load of the plant. Usually, all the heating is done by utilizing live steam direct from the boilers. For both types of installation, it is highly desirable to heat the water instantaneously as it is wanted, thereby decreasing radiation losses.

The Wainwright domestic water heater is of the water-tube instantaneous type. It is made of cast iron throughout with the exception of the heating surface; hence corrosion is minimized. The heating surface consists of the Wainwright spiral flow tubing which is a straight hard brass tube, expanded into one tube head and passing through a deep stuffing box of the condenser type in the other tube head. Upon the inner surface of the tube, winds a spiral coil which agitates the flow of the water through the tube, securing for a given amount of heating surface a high rate of heat transmission.

The method of accommodating expansion and contraction makes this apparatus applicable for use on either high or low pressure steam, for either intermittent or constant service, without possibility of injurious strains being put upon any part of the apparatus. For installations in which the storage of water is necessary, a storage tank is furnished in connection with the heater.



WAINWRIGHT DOMESTIC WATER HEATER

When a constant temperature of the water is desired, an automatic temperature regulator of an approved manufacture is supplied. The accompanying cut shows the Wainwright spiral flow heater as equipped with a temperature regulator. The apparatus is manufactured by the Alberger Condenser Company.

TEST FOR GREASE

THE great majority of engineers carry a responsibility and have a confidence reposed in them that few people realize. This is in the purchasing of power and mechanical supplies. It is surprising the number of concerns, and among them some of the largest in the country, employing alleged experts and maintainings large purchasing departments, that place their real and final reliance upon the engineer in securing advice to enable them to reach a decision in purchasing their power supplies. His common sense and good judgment are fully realized and depended upon.

One of the most difficult things to buy is lubricant, but the following simple test can easily be made.

The main thing to secure in any lubricant is the greatest amount of lubrication at the lowest cost. In conducting a simple but good and practical test, take any grease as for instance Albany made by Adam Cook's Sons of New York, and place a spindle cup on the engine, shafting or machinery upon which the test is to be conducted, being sure the cup is thoroughly cleaned before it is used in the test. Fill the cup with a known quantity of the grease, then place it in operation. Then note the quantity that is used each day. Albany grease or other with a low melting point runs only when it is needed. The spindle of the grease cup made of soft copper rests on the shaft. As the shaft revolves, the conductivity of the copper spindle causes the grease that is packed around it to flow; when the shaft is not in motion the spindle is, of course, not heated and naturally the grease does not soften and flow. This condition produces the maximum amount of economy.

To learn the lubricating qualities, after the cup has been in service for sometime, note whether there is anything left in the cup. Pure grease has all been used up with absolutely no residue left. Where there is no waste it means that everything you buy can be used, and used with good results. With Albany or other grease that contains no impurities the cup and the bearings will show up as fine as the day they were made.

NEWS NOTES

EXAMINATION WILL be held on September 11th and 12th in the principal cities of the country for engineer draftsman. The position is open to citizens of the United States 18 years or over who have had not less than 5 years' practical experience, 2 years in steel designing or construction work. A degree from a technical school will be considered as equivalent to 2 years of experience. Salary is from $1600.00 to $2000.00. The position is in the supervising architect's office in Washington. Subjects for examination, Practical Quesitions in Engineering, on Construction of Structures, 60 points; Training, Experience and Fitness, 40 points. On the latter a rating of at least 70 per cent on the subjects presented must be secured. Two days of 7½ and 7 hours respectively allowed for the examination. The use of slide rule and the Carnegie Steel Co.'s handbook permitted. Drawing board, instruments, ink and pencils to be brought by applicants. Application should be filed with the U. S. Civil Service Commission at Washington on Form 1312, which can be had from them.

RECENTLY THE EDISON ILLUMINATING CO., Detroit, ordered 11 vulcan soot cleaners, and the manufacturer, G. L. Simonds & Co., Chicago, are also to equip one of the Edison 2400 hp. Stirling units, the largest in the world. This is the eighth repeat order received from the Edison Company in the past 11 yr. The C. & N. W. R. R. Co. ordered 7 more cleaners, making a total of 100 Vulcans. The Cleveland Elec. Illuminating Co. also recently placed a repeat order, making a total of 34 Vulcan cleaners.

ON AUGUST 1, Frank H. Evans, for the past 7 years manager of the New England office for the Strong, Carlisle & Hammond Co. of Cleveland, Ohio, resigned his position and will take a long rest before resuming active work again.

A. O. KRIEGER has resigned his position as Publicity Manager of the Busch-Sulzer Bros.Diesel Engine Co., of St. Louis, and has opened an office at 916 Victoria Bldg., St. Louis, for the sale of oil burning devices suitable for domestic heating and cooking, and for japanning and annealing ovens.

CATALOG NOTES

FOR LINING FURNACES, the Botfield Furnace Lining, including fire brick cement, Fibricon, plastic fire brick concrete, and Furnacite, all made by the Botfield Specialties Co., of Philadelphia, are found of great help, and are described in the pamphlet on furnace linings issued by the company. Another catalog by A. B. Botfield & Co., shows boiler furnace specialties, including furnace enamels, grate bars and boiler castings.

BULLETIN No. 491, issued by Triumph Electric Co., Cincinnati, O., describes its new direct current steel frame motor. These motors are of compact construction, neat appearance and are light in weight.

PRATT & CADY CO., of Hartford, Conn., in its 1912 catalog has produced a book of steam specialties which will be found of great convenience to every one who possesses it. It gives dimension lists of all the different styles of gate and globe valves, angle valves, quick acting valves and special forms made by the

company and illustrates also various special forms of couplings and pipe fittings as well as a full line of regular equipment for pipe lines of all kinds. It is a handsome book printed on heavy coated paper containing 225 pages and with a complete index. It is bound in a cloth binding and will stand hard usage and frequent consultation.

BULLETIN No. 4932, issued by the General Electric Company, is devoted to the application of electricity in the brewing industry.

BULLETIN No. 4976, recently issued by the General Electric Company, is devoted to electric drive in grain elevators and flour mills, and supersedes the company's bulletin on this subject.

CUTS OF THE LYTTON steam traps and a full description of how these operate are shown in the new catalog issued by the Lytton Mfg. Corp., Hudson Terminal Bldg., New York City. A supplementary folder also describes the Lytton boiler blowoff valve, which is especially designed for frequent operation and hard service.

FROM THE G. B. ESSEX Brass Co., of Detroit, Mich., manufacturers of lubricators and lubricating devices, comes a very complete catalog, showing oil pumps and cups, grease cups, indicator and dial pumps, mixing valves, multiple oilers, sight feeds and manifolds for automobiles, and many special devices, all of which are clearly described and illustrated in an interesting manner.

POSITIVE PRESSURE BLOWERS is the title of an attractive 6 by 9 catalog just issued by Albert J. Kelting, of Brooklyn, N. Y. This catalog gives a comparison of the different methods of moving air for high, low and intermediate pressures, and then contains a full description of the Kelting Positive Pressure Blower.

NEW PUBLICATIONS of the Bureau of Mines, Department of the Interior, are as follows: Bulletin 18, on the Transmission of Heat Into Steam Boilers, by H. Kreisinger and W. T. Ray. Technical papers: No. 17, on the Effect of Tamping on Efficiency of Explosives. No. 18, Magazines and Thaw Houses for Explosives. No. 23, Ignition of Mine Gas by Miniature Electric Lamps. Reprints are available of Bulletin 40 on the Smokeless Combustion of Coal in Boiler Furnaces, and technical paper 21, on the Prevention of Mine Explosions.

CATALOG No. 12-1 of the Hunt Industrial Narrow Gage Railways, issued by the C. W. Hunt Co., of West New Brighton, N. Y., is an interesting booklet on an important subject. It shows the different styles of cars adapted for boiler room and other industrial work and how the narrow gage track may be made up to serve any part of the plant by means of switches, curves, cross-overs and turn-tables. Complete data in regard to all parts of the system are given in the pamphlet.

TWO CATALOGS received from the Link Belt Co. deal first, Book No. 141, with the Link Belt Silent Machine Drive for mills and facories and second with the Link Belt Locomotive Trains. Each book is a complete description of the apparatus treated upon and shows the operation of the devices and how they may be used to best advantage for different purposes.

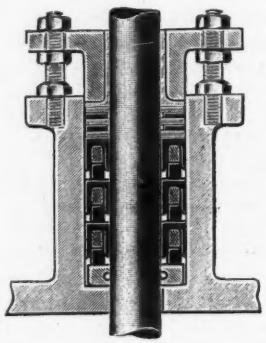
DESCRIPTION OF the construction and directions for using the combination pump valve as made by D. F. Stayman of Philadelphia is given complete with price list in his folder.

BRIGHTENING THINGS is the title of an attractive booklet sent out by the Rath Mfg. Co., of Philadelphia, describing its Imperial Paste Metal Polish which will cleanse all metals, hot or cold, without injury. The pamplet describes also the Imperial Liquid Metal Polish and the Imperial Polish for cut glass, gold and silver.

TRADE NOTES

SINCE POWER compressors and internal combustion engines particularly, have been on the market complaints exist about unsuitable packings for stuffing boxes, caused by the introduction of high pressure and high temperature. The high temperature of the latter is permitted by the use of the so called Metallic packings. These are generally made of white metal and different kinds of bronze which insures a continued tightness to the packing.

Excellent results have been secured from a special metallic packing known as Goetze Style B used on superheated steam and high speed engines. It is made of bronze and white metal and has been on the European market for years. Recently the Goetze Compressor metallic packing, shown in the illustration, has



been developed and although an entirely new construction has given excellent results. It possesses antifriction qualities which make compression economical and any machinist can easily install the Goetze metallic packing which is manufactured by The Goetze Gasket & Packing Co., at its new factory in New Brunswick, N. J.

THE VILTER MFG. CO., with offices at 972 Clinton St., Milwaukee, Wis., report the following recent sales: Gehling Brewing Co., Falls City, Neb., 40-ton refrigerating machine driven by 14 by 30-in. Corliss engine; The Hutchinson Co., Ice Cream Mfrs., Cedar Rapids, Ia., 55-ton refrigerating machine driven by 15 by 30-in. Corliss engine; Ambrosia Chocolate Co., Milwaukee, Wis., 12-ton refrigerating plant; A. H. Barber Creamery Supply Co., Chicago, Ill., 30-ton refrigerating machine and 15 by 30-in. Corliss engine; Heinecke & Kaufmann, Meat Market, Sheboygan, Wis., 5-ton brine refrigerating plant, piping, etc.; H. J. Frank Co., Nennah, Wis., 6-ton brine refrigerating plant, piping, etc.; French Market Ice Mfg. Co., New Orleans, La., 100-ton refrigerating and 90-ton ice-making plant and 22 by 42-in. Corliss engine; F. A. Holliger Co., Who. Confectionery, Findlay, O., 25-ton refrigerating plant; Troy Laundry Co., Los Angeles, Cal., 15 by 36-in. Corliss engine; Jos. Schwartz Brewing Co., Hartford, Wis., 25-ton refrigerating plant and 12 by 30-in. Corliss engine; Hygienic Ice Co., Chicago, Ill., 300-ton can ice plant, 2 30 by 48-in. Corliss engines; Artesian Ice and Cold Storage Co., Texas City, Texas, 25-ton can ice plant and brine refrigerating system, 15 by 30-in. Corliss engine; Reedsburg Brewing Co., Reedsburg, Wis., 23-ton refrigerating plant and 12 by 30-in. Corliss engine; Samels Bros. Co., Creamery & Who. Produce, Minneapolis, Minn., 18-ton brine refrigerating plant.

Sparks From The Advertising Pages

Human interest is a most valuable quality in all reading matter which is intended to attract and hold attention. Metropolitan newspapers make a big thing of this human element—retain star reporters, whose sole duty is to dig up stories full of human appeal.

This is psychologically true of advertisements, too. An advertisement with a good, strong touch of human interest will attract attention and hold it with a consistency that is perhaps unrivalled.

Technical advertising, however, would seem to be about the last field in which this style of copy would be successful. The mechanical mind of the reader is interested by technical description and illustration. It revels in mechanical drawings and charts, for it reads the advertisements for their practical value.

But human nature is much the same in all walks of life. The Quaker City Rubber Company has succeeded in infusing the human interest element into its advertising without detracting in the least from the technical features of the copy.

They have rather been emphasized, as the following two letters show:

Grand Rapids, Mich.,
April 30th, 1912.

Practical Engineer,
537 Dearborn St.,
Chicago, Ill.

Gentlemen:—The advertisement of the Quaker City Rubber Company appeals to me very much and I think it is the most attractive one, because the pictured heading with the serious expression of the man's face and the question of your daughter's education creates a feeling in the reader that induces him to read the entire advertisement.

He realizes that he must give the cost of power lost through different packing a serious thought. The explanation of tests run on solid packing induces the reader to give P. P. P. packing a trial.

Respectfully yours,

Wm. De Groot,
Grand Rapids, Mich.

Valdosta, Ga.,
May 16th, 1912.

Practical Engineer,
Chicago, Ill.

Gentlemen:—The P. P. P. advertisement appeals to me most because of the manner in which they appeal to the engineer. I refer to "The question of your daughter's education." Nothing appeals to the father more than the welfare of his child and when he sees the above extract, he immediately would wish to learn its meaning and read the advertisement. Very truly yours,

Leo. H. Weinkle.

In these instances the advertisement has struck home with a double "reason why." It has shown the reader not only why the product is good, but why he should be sure that it *is* good—why, from a standpoint of his own duty, it is imperative that he investigate and make sure that he is getting the best; and as one of the letters says, "the question of your daughter's education creates a feeling in the reader that induces him to read the entire advertisement."

Advertisers are realizing more and more that to produce results, they must put something more into their copy than the mere conventional card setting forth their names and addresses. This sort of copy has long ago become obsolete and the manufacturer who is putting the same progressive ideas into his advertising that he is putting into the other departments of his business is the one who is making it pay.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By A1 reliable engineer. Understands slide valve, Corliss and equipment, condensers, plant lighting, etc. Address Box 197, Jennings, La. 9-1-1

POSITION WANTED—By an engineer, 20 years experience in central stations. Strictly sober. Married. Age 38. Address Box 234, Practical Engineer, Chicago, Ill. 8-1-3

POSITION WANTED—By gasoline engineer to run a pumping plant; understands wells and pumps. Wants all-year-round work. Married. Good references. Address Marshall Hughson, 11 E. Travis St., Grand Rapids, Mich. 9-1-1

POSITION WANTED—As oiler in power plant. Can do steam fitting, and handy all around man. Have had four years experience. Please give full details reply. Address Box 238, Practical Engineer, Chicago, Ill. 9-1-1

POSITION WANTED—By an engineer; 9 years experience in central stations and heating plants. Parsons Turbines. Strictly sober. Married. Age 27. Minn. state Chief Eng. license. Best of references. Address Box 240, Practical Engineer, Chicago. Ill. 9-1-1

POSITION WANTED—As manager of electric light and power plant in town of 2000 to 5000 population. 8 years experience as operator and manager of hydro and steam plants, high speed and Corliss engines, A. C. and D. C., high and low voltage, and sub-station work. Temperate, steady and reliable. Address Box 239, Practical Engineer, Chicago, Ill. 9-1-1

Help Wanted

SALESMAN WANTED—Traveling in the Middle West, to handle the best known and most successful rocking grate on the market. Salary or commission. Address Box 242, Practical Engineer, Chicago, Ill. 9-1-2

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J. tf

WOULD ONE HUNDRED DOLLARS per week interest you? Would you like to be outside in the fresh, invigorating air during the coming months? Free to do your own bidding and earning $100.00 or more per week, as you choose? Your own boss. We want one first-class salesman to represent us, in every city in the United States, to sell our high-grade specialties to Engineers. Exclusive territory given. Strong Machinery & Supply Co., 48 Franklin St., New York City. tf

Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf

WANTED—SALESMEN TO WORK counties calling on voters for our New Census publications. Largest publishing house in the world back of you. Permanent if satisfactory. Establish your future now. Men making $50 to $75 per week. Rand McNally & Co., Dept. B, Chicago, Ill. 8-1-5

For Sale

FOR SALE—HIGH PRESSURE BOILERS, 54x16, 60x16, 66x16, 72x18. Corliss Engines 10x30, 12x36, 14x36, 16x42, 18x36, 18x42. Generators, Motors, Miscellaneous Machinery. The Randle Machinery Co., 1767 Powers St., Cincinnati, Ohio. 7-15-6

FOR SALE—INDICATOR REDUCING WHEEL, planimeter, best make, in fine order. Examination allowed before payment; price low—in fact, a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf

FOR SALE—WAINWRIGHT HEATER, 400 H. P. copper corrugated tubes, excellent condition, low price, Harris Machinery Co., Minneapolis, Minn. 7-1-6

FOR SALE—22x48 Wetherill Corliss engine, in perfect condition, $775; 20x48 Brown, $600. Duzets & Son, Hudson Terminal, N. Y.

Patents and Patent Attorneys

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf

WE SELL PATENTS. Established ten years. To buy or having one to sell write Charles A. Scott Co., 1098 Granite Bldg., Rochester, N. Y. 8-1-6 e.o.i.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.e.o.i.

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 9-1-2

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf

FIND OUT FOR YOURSELF what to invent and how to protect it. My book, "Inventors' Universal Educator," covers the matter from A to Z; also gives 600 Mechanical Movements and 50 Perpetual Motions. Price $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C. 9-1-1

Educational and Instruction

A SWINGLE'S TWENTIETH CENT'Y Hand Book Free to the subscriber who writes the best 750 word article on the reading matter he likes best in Practical Engineer, and why? Address the Contest Editor. 9-1-1

Miscellaneous

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